



SIERRA CLUB

DISCOVERING SUSTAINABLE, CAREER JOBS AT CLOSING MILITARY BASES

*A Sierra Club San Francisco Group
Research Project*

May 1994

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Sierra Club San Francisco Group is the local chapter of the Sierra Club, a 501(c)(3)-member national environmental advocacy and conservation organization. The SFQ has approximately 3,000 members within San Francisco County and focuses on policy environmental issues such as toxic chemicals, open space, recycling and water.

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

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About Sierra Club San Francisco Group

Sierra Club San Francisco Group is the local body of the Sierra Club, a 500,000-member national environmental advocacy and conservation organization. The SFG has approximately 9,000 members within San Francisco County and focuses on urban environmental issues such as toxics, transportation, open space, recycling and water.

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Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

The closure of military bases in northern California creates an opportunity to convert industrial lands and the activities conducted on them to more environmentally sustainable uses. Some of the lands will probably be slated for open space, housing and commercial uses. Others will likely be zoned for light industrial uses, to meet the employment and economic needs of the communities that are established on and near the bases.

INTRODUCTION Sierra Club's San Francisco Group (SCSFG) wishes to assure that the jobs created during redevelopment of military sites are environmentally sustainable and provide long-term employment.

In order to encourage successful transition to such jobs at closing northern California bases, SCSFG undertook a research project, **Discovering Environmentally Sustainable, Career Jobs at Closing Military Bases**. The report explores potentially environmentally sustainable industries which may be appropriate at closing bases. The study emphasizes industries that would meet all applicable local, state and federal pollution control requirements, and that hold the promise of stable employment for residents of surrounding communities. A special concern was identifying a mix of small, mid-size and large companies that can provide job opportunities for entrepreneurs, entry level, blue-collar and white-collar workers.

Sierra Club wishes to be at the forefront of discovering environmentally friendly, career jobs for Californians at a time of economic distress. With this report—which helps identify environmentally promising light industrial and other uses at former military lands in urban settings—the Club has taken an important step in debunking the jobs versus environment myth.

Defining "Environmentally Sustainable"

Sierra Club recognizes that almost no modern industrial operation—or human endeavor—is entirely environmentally sustainable. A truly sustainable society will give greater emphasis to conservation and efficiency, rely more on renewable energy, and extract nominally renewable resources only to the degree that they can regenerate themselves. It will need to minimize waste, maximize reuse and recycling, avoid the use of hazardous materials, and preserve biodiversity. And it will need to develop more environmentally benign production technologies, and design products to be more durable and repairable.¹

Environmentally sustainable business operations would be non-polluting, use local resources and labor, require minimal transportation, use only renewable resources, and consume only the amount of resources to meet current needs while ensuring adequate resources are available for future generations. This ideal is highly improbable without dramatically different American consumption, demographic, education and migratory patterns.

We currently have "an industrial system that has immeasurably raised economic standards of living for those lucky enough to participate, but at the same time is destroying the foundations of its own prosperity."² Unlimited economic growth and environmentally sustainable development are not compatible goals.

For these reasons, Sierra Club states that few, if any, of the industries or specific companies discussed in this document are environmentally sustainable by strict definition. Nor does the Club unqualifiedly endorse any of the mentioned industries or businesses.

However, we recognize that as former U.S. Representative Pete McCloskey, Jr. put it at a 1992 Sierra Club conference, "Most people want the best environment they can get while still having the dignity of having a job." An environmental movement that cannot support job creation in industries that move society towards our goals of resource conservation and sustainable development is a movement in danger of obsolescence.

Therefore, for the purposes of our research, **we have defined an environmentally sustainable, urban-based industry as one that complies with all environmental regulations, is either net-beneficial to or net-benign to the environment and creates stable jobs with career potential.** This report concentrates on businesses that

- can provide meaningful employment for people living near closing military bases,
- make progress towards environmentally sustainable operations,
- do not make significant use of nonrenewable resources or toxic substances, or generate significant hazardous wastes,
- emphasize local manufacturing and distribution,
- have proven records of compliance with environmental regulations,
- and/or improve environmental quality overall.

As much as possible, the environmental impacts of industries and technologies covered have been evaluated for their "life-cycle" impacts; not only direct impacts from manufacturing/use, but also their indirect role in helping solve larger environmental problems and in reducing high-polluting and fuel-consuming distribution networks.

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Scope & Methodology of Research

This report was researched and compiled entirely by Sierra Club volunteers who collectively contributed well over 550 hours to the project. Administrative costs (copying, distribution) were covered by grants from Sierra Club San Francisco Group and Sierra Club Bay Chapter. Work was divided into six phases:

1. Establishing a definition for an environmentally sustainable, urban-based industry;
2. Examining current land uses and existing infrastructures at several Bay Area bases;
3. Compiling a list of "environmentally sustainable" industries potentially suitable for siting at closing bases and performing preliminary research on them;
4. Circulating a draft report to approximately 50 Sierra Club decision-makers, citizens/agencies involved in base redevelopment activities, businesspeople, select elected officials, an economist and labor activists;
5. Revising the draft; and
6. Distributing the report.

The team of volunteers divided the industries researched into six categories:

- Alternative energy (solar, alternative fuels, energy efficient appliances, residential weatherization materials);
- Recycling/source reduction/composting;
- Residential pollution prevention/control (chemical-free dry cleaners, air duct cleaning services, "clean" custodial services, interim household lead control);
- Environmental cleanup and restoration;
- Agriculture and aquaculture (fish farms, "closed-loop" organic farming, other sea-based crop cultivation, native plant cultivation); and
- Advanced transportation (electric cars, natural gas vehicles, high speed rail).

For most categories, the researchers have indicated:

- a description of the industry/specific technology;
- the market potential (projected revenues, customers demand) of the industry;

- the job creation potential of the industry;
- environmental, health and safety issues;
- the infrastructure required to “set up shop” (buildings, transportation, labor force skills); and
- a list of companies, agencies and associated organizations active in the industry.

During the research and review processes, multiple other ideas on potentially environmentally sustainable businesses were generated. Many of these may warrant further research; the Conclusions section of this report lists these industries and ideas.

What's the Next Step?

Sierra Club recognizes that conversion of closing military bases requires more than the siting of environmentally sustainable industries. The interconnectedness of economic, social and environmental problems means all must be addressed in concert. Environmentally sustainable job creation will ideally be accompanied by targeted training/education programs, affordable housing opportunities, greater accessibility to open space and recreational facilities, better mass transit, and other appropriate social programs (effective crime prevention, better support of family structures through increased availability of health, family planning and day care programs).

Nevertheless, we view the identification of potentially environmentally sustainable jobs and industries for these bases as an important step. Future Sierra Club activities could include:

- Working with neighborhood/community/policy decision-makers to help decide on the preferred environmentally sustainable job options for converting military bases;
- At the request of community leaders, assisting in further information-gathering to determine the feasibility of bringing acceptable industries or specific companies to a site.

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

EXECUTIVE SUMMARY

The objective of this report is to identify career jobs in environmentally sustainable industries that would be appropriate for decommissioned northern California military bases. The document is intended to be a hands-on tool for environmentalists, community and neighborhood leaders, redevelopment planners, elected officials and the business sector as they formulate their plans for conversion.

Business Categories Examined

- Alternative energy (solar, alternative fuels, energy efficient appliances, residential weatherization materials);
- Recycling/source reduction/composting;
- Residential pollution prevention/control (chemical-free dry cleaners, air duct cleaning services, "clean" custodial services, interim household lead control);
- Environmental cleanup and restoration;
- Agriculture and aquaculture (fish farms, "closed-loop" organic farming, other sea-based crop cultivation, native plant cultivation); and
- Advanced transportation (electric cars, natural gas vehicles, high speed rail).

Primary Findings— Alternative Energy

- **Renewable and energy-efficiency technologies** such as solar energy, energy-efficient appliances and residential weatherization hold promise for reducing energy consumption. They also create more jobs and produce fewer (even no) pollutants and hazardous wastes than conventional energy industries.
- **Solar technologies** are a long-term prospect, since they are not likely to mature before the early 21st century. The manufacture of solar water heaters, solar-electric components, solar collectors, hydrogen storage equipment, and other solar equipment could make use of existing infrastructures at military installations. As a leading-edge technology and engine of long-term job growth, solar applications should be meticulously evaluated as part of redevelopment planning.
- **Fuel cell manufacturing** is one of the greatest prospects identified in this report. Fuel cells are used both in electricity production and to supply energy for transportation. They are a highly promising alternative energy source. For example, a Hunters Point location would put production close to the largest domestic geographic market segment for a U.S. fuel cell manufacturing operation. Moreover, the electricity requirements of a fuel cell factory could in

theory be met by an on-site fuel cell power plant, a self-contained promotional model for the product. The availability of skilled laborers and qualified technical personnel from closed military sites make a Bay Area fuel cell manufacturing plant an attractive possibility.

- **Manufacture of energy-efficient refrigerators** needs further research, to assess the lifecycle impacts of these products. Some models continue to use extremely environmentally harmful chemicals (chlorine, bromine, CFCs, HCFCs, HFCs and other synthetics) in their production, and most continue to be powered by fossil fuels or other unsustainable energy sources. While CFC/HCFC-free models are available, they tend to be energy-inefficient, compared to the new efficiency models.
- **Evaporative cooling manufacturing** and installation represents a significant and exciting job creation opportunity at locations with large blue collar worker populations. Environmental impacts would be comparable to a sheet metal shop.
- **Residential weatherization** materials manufacturing and installation are unlikely to create a large number of career jobs in the near future in the San Francisco Bay Area. However, any increase in construction volumes could change this picture. In the same vein, manufacture of pre-fab energy-efficient homes could be a high-volume job creator, depending on the housing market. Energy-efficiency consulting is a strong possibility for those with some technical education and aptitude. A retail "one-stop shop" for weatherization, including warehouse outlets selling environmentally sensitive materials, installation services and research and educational facilities, could be an option.

Residential pollution prevention/ control

- There is considerable potential for **environmentally safe garment cleaning businesses** to achieve significant market share. Such enterprises represent business ownership opportunity for aspiring entrepreneurs, especially since there is a likely source of capital investment loans to help start up these businesses. Clean dry cleaning operations also require little training. A determination on the type and location of residential areas to be sited in converting bases must be made before the feasibility of clean dry cleaning operations on bases can be judged. Or the businesses could target local the hotel/restaurant industries as the primary market.
- The **air duct cleaning industry**, while competitive, is expected to expand with the passage of new legislation and increasing concern over indoor air quality. There are thousands of office buildings, large apartment buildings and private residences in the Bay Area

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

and beyond that could have a need for air duct cleaning services. Such businesses require little education/training, a \$50,000 to \$100,000 capital investment and 1,500-2,000 square feet of office/warehouse space, making them another excellent possibility for entrepreneurs.

- A business providing **environmentally safe house cleaning services** may be a source of jobs at decommissioned bases. Commercial businesses that require janitorial services and households seeking domestic help are potential markets for this business. Sales of "green" cleaning products by catalog and retail store is a natural expansion opportunity for such a business. However, this would require siting the business in a high-traffic retail site, making this type of store feasible only at bases where retail uses are planned.
- A project to perform **interim lead hazard reduction** in low- and moderate-income private housing in San Francisco is under way, and will hire youths, unemployeds and people connected with work programs.

Recycling/ source reduction/ composting

- The range of products, services and companies with potential to contribute to a recycling economy is nearly limitless. Some of the innovative recycling and **source reduction** business opportunities that may be appropriate for closing bases include: a biopolymer packaging manufacturing plant; a cardboard box reuse facility; used motor oil filter and used asphalt pavement recycling facilities; a high-tech composting toilet fabrication plant; plastic bucket beneficiation and other plastics recycling facilities; and furniture and building material refurbishing/recycling operations.

Environmental technology

- Competition for attracting **environmental cleanup** firms at closing military bases and in other California communities is fierce. The Bay Area is the worldwide capital of environmental cleanup companies, and it is likely one or more of the closing bases in the region will present opportunities for siting such firms. For example, companies currently holding contracts on cleanup/investigation work at any given base are likely candidates to open branches/offices at that site. Emergency marine response firms could be highly interested in any base offering Bay access. A proposal for the Naval Air Station - Alameda would create an industrial park focused on developing environmental technologies.
- **Ecological restoration** of California natural resources (streams, wetlands, forests, mining sites, roadsides) could be a \$50 to \$100 million business over the next five years, and a multi-billion market in the long term. The Bay Area is also the center for this nascent

industry. Almost every closing northern California base is an excellent choice as a center for urban natural area restoration. They could serve as laboratories for testing wetlands, creek and hillside restoration techniques, and provide appropriate office infrastructure for restoration companies.

Agriculture/ aquaculture

- San Francisco, Oakland, San Jose and Sacramento host huge restaurant and consumer markets, making closing bases there attractive sites to **fish farm and organic agriculture companies**. A high density fin-fish farm would be well suited to a base site, since fish could be raised in tanks inside vacated warehouses and workshops. A farm which is sited on a total area of ten acres (including parking lots, support buildings, etc.) could produce approximately four million pounds of fish per year. It would also offer immediate employment opportunities in a growing, environmentally benign industry for local people.
- **Raised bed farming** of organic produce is a potentially "closed loop" industry with a certain market that makes good sense for some former military installations. Other agriculture-related industries for further consideration are native plant/tree/flower/seed nurseries, an organic landscaping business, composting, worm breeding, kenaf cultivation and treeless paper manufacturing. Further economic analysis is needed to determine feasibility of these opportunities and the potential of siting such companies at converting bases.

Advanced transportation

- Manufacturing of most dedicated **natural gas powered vehicles** (NGVs) is almost certain to take place outside California. However, some research/development and manufacturing of related components and services (natural gas storage tank manufacturing, retrofitting facilities, refueling station construction, training centers for technicians and mechanics, NGV repair shops) could be possibilities for more than one closing base.
- **Electric cars** powered by nickel-metal-hydride (NiMH) batteries, and especially flywheel batteries and fuel cells are the most promising electric vehicle (EV) power technologies. It may be difficult to attract EV motor or assembly manufacturers to California. However, electric car recharging stations and retrofitting facilities are two related growth industries highly appropriate for siting at former bases.
- If anti-rail lobbying by Detroit can be overcome, **magnetic levitation train** development/manufacturing/construction will be a \$400 million industry in California around the year 2000. Most northern

California fast rail-related jobs are likely to be R&D work on components and to be centered in Silicon Valley. However, companies specializing in support jobs (construction of tracks, maintenance) are possibilities for decommissioned bases.

Conclusions

Conversion of California military bases constitutes a tantalizing opportunity to create neighborhoods that are pedestrian-friendly and transit-accessible, that include a mix of commercial/light industrial space and high-density/low-cost housing, and offer ample recreational and open spaces. Any such redevelopment model will ideally be constructed on a foundation of social justice, cultural diversity, local ownership and ecological sustainability.

Sierra Club/San Francisco Group is hopeful about the chances for realizing this vision at decommissioned California military bases. This report, **Discovering Environmentally Sustainable, Career Jobs at Closing Military Bases**, focuses on businesses that have potential to provide a range of meaningful blue collar, white collar, entry level and entrepreneurial employment for people living near closing military bases.

In some instances, the report also identifies local job training, education and placement programs, and link these programs to expanding environmental job opportunities that are projected to occur over the remainder of the century and beyond.

¹ "Jobs in a Sustainable Economy," Renner, Michael, *Worldwatch* Paper 104, September 1991, p.8.

² "The Real Price of Free Trade," Harold Gilliam, *This World*, *San Francisco Chronicle*, Jan. 2, 1994. P. 13.

ALTERNATIVE ENERGY

Introduction

As the U.S. economy's dependence on foreign oil grows, the need for alternative energy sources becomes increasingly apparent.

The U.S. is rich in natural resources, but its energy production is heavily dependent on foreign oil. This dependence has led to a steady increase in the price of oil, which has in turn led to a steady increase in the price of gasoline. This increase in the price of gasoline has led to a steady increase in the price of transportation, which has in turn led to a steady increase in the price of goods and services.

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Energy production and consumption are closely linked. As the U.S. economy grows, the need for energy grows. This need for energy has led to a steady increase in the price of oil, which has in turn led to a steady increase in the price of gasoline. This increase in the price of gasoline has led to a steady increase in the price of transportation, which has in turn led to a steady increase in the price of goods and services.

In 1980, the U.S. government passed the Energy Conservation Act, which set a goal of reducing energy consumption by 25 percent by the year 2000. This goal has led to a steady increase in the price of oil, which has in turn led to a steady increase in the price of gasoline. This increase in the price of gasoline has led to a steady increase in the price of transportation, which has in turn led to a steady increase in the price of goods and services.

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The problem is not just the U.S. but the world. The world is rich in natural resources, but its energy production is heavily dependent on foreign oil. This dependence has led to a steady increase in the price of oil, which has in turn led to a steady increase in the price of gasoline. This increase in the price of gasoline has led to a steady increase in the price of transportation, which has in turn led to a steady increase in the price of goods and services.

Therefore, reducing energy usage and conserving energy are two of the most important things we can do to reduce the price of oil. This reduction in the price of oil will lead to a steady increase in the price of gasoline. This increase in the price of gasoline has led to a steady increase in the price of transportation, which has in turn led to a steady increase in the price of goods and services.

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ALTERNATIVE ENERGY

Introduction

Renewable Energy: a Powerful Source of Jobs

Over the long term, the economic benefits of investment in solar technologies—sustained increases in income and in skilled, well-paying jobs—may be even more important than the environmental gains. Competitive, “leading edge” industries such as solar power are the engine of long-term job growth.

When measured in jobs per million dollars of annual expenditure, coal, oil, gas and nuclear technologies support among the fewest jobs of any economic activity.⁶

In contrast, energy efficiency and solar investments have greater job creation potential than conventional energy sources.⁷ The American Council for an Energy-Efficient Economy and Economic Research Associates found in a 1992 study that a national strategy of investment in environmentally benign energy sources, conservation and energy efficiency would create 1 million net new jobs in the United States within ten years.⁸

Energy production and consumption have one of the greatest environmental impacts of any human activity. The most critical technologies for environmentally sustainable development are therefore energy-efficiency-related.

In 1990, the U.S. spent about \$500 billion for energy from a variety of sources including electricity, natural gas, gasoline, wood and other fuels. An estimated 1.4 million workers were employed in the energy industry.

But currently, only about 8 percent of U.S. primary energy supply is provided by renewable sources. And no lasting cure for our deteriorating environment—particularly the problem of global warming—is possible without reducing fossil fuel consumption and developing alternative fuel sources. The concentration of carbon dioxide in earth’s atmosphere is up 25 percent from preindustrial times, with concentrations of other greenhouse gases such as methane and CFCs also on the rise.¹

The chief source of greenhouse gases is the combustion of fossil fuels. Fossil fuel use accounts for about half of the warming that is estimated to have occurred in the 1980s and over half of the warming predicted for the next 100 years.

The problem is especially acute in the United States, which hosts just 5 percent of the world’s population but contributes about 24 percent of world carbon-dioxide emissions from fossil fuels. In the U.S., fossil fuels consumed to generate electricity are the largest source of carbon dioxide, emitting about 35 percent of the total, followed by transportation, industry (about 25 percent) and residential and commercial buildings uses.

Therefore, reducing energy usage and switching to more environmentally benign energy sources in the U.S. can significantly lower global greenhouse gas emissions, reduce air pollution and limit oil imports. It can also save consumers money; for example, a solar water-heating system can be expected to save a homeowner about \$250 to \$500 in energy costs per year if the fuel displaced is electricity, and about a quarter as much if the fuel displaced is natural gas.

Moreover, renewable energy industries generally generate more jobs, per unit of energy produced, than coal, oil and natural-gas industries, since their capital requirements (with the exception of photovoltaic cells) are more modest and their labor needs greater.² A 1992 study by the American Council for an Energy Efficient Economy (ACEEE)³ comparing high energy efficiency and business-as-usual scenarios found that cost-effective efficiency improvements could lead to an additional 471,000

Another 1992 joint study by the American Gas Association, the Solar Energy Industries Association, and the Alliance to Save Energy examined the employment impacts of an alternative energy scenario. By 2010, under the alternative energy scenario, energy conservation services and renewable energy technologies would gain 194,700 jobs. Jobs in gas and oil production would increase by 25,500 while coal production would lose about 44,500 jobs, for a net increase of 175,700 jobs. Moreover, the study did not estimate the impacts of indirect employment gains; it is likely the lower energy bills projected under the alternative energy scenario would increase consumer spending, stimulating an even greater increase in job levels.¹

Another study, a 1979 analysis by the Council on Economic Priorities, looked at the employment impacts of various energy sources. It found that conservation and solar would create up to 1.4 times as much national employment per unit of energy supplied or saved, compared to a proposed nuclear power plant. In addition, 2.4 to 2.7 times more employment would be created nationally than would the equivalent use of oil, natural gas, and electricity.

jobs in the United States by the year 2000, and 1.1 million jobs by 2010.⁴ (See the sidebar for more on the job creation potential of renewable versus conventional energy sources.)

One more benefit is the tremendous export market potential for energy-efficient technologies; the Eastern European industrial sector alone is estimated to be a \$20 billion annual market.⁵

But unless obstacles to these industries are addressed, solar energy and energy-efficiency technologies will very likely remain at the margins of the U.S. economy for at least another decade and quite possibly longer. A glut of low-cost fossil fuels, cutbacks in federal research and development funding, low consumer awareness, and the failure of markets to account for the environmental impacts and social costs of conventional fuels have slowed the industry's growth. At modest scales, almost all solar-thermal electric technologies are simply too expensive to compete in today's electricity markets without special tax incentives or other supports. But competitiveness is enhanced at larger scales, such as the former Luz plant in Southern California.

The renewable and energy-efficiency technologies which are described next—solar energy, energy-efficient appliances and residential weatherization—are technologies that hold promise to not only reduce energy consumption but also to produce fewer (even no) pollutants and hazardous wastes. In addition, their development would result in a net increase in employment. Of the many energy-efficiency initiatives related to non-transportation energy consumption, evaporative cooling and solar energy technologies are likely the most appropriate for development at closing northern California military bases.

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

**Types of Industry/
Business** Solar building systems, solar collectors, solar water heaters, solar thermal concentrating systems, photovoltaic systems

**Main Solar Energy
Systems** There are **three main types of solar energy systems** - solar buildings, solar/thermal systems (including solar collectors and solar thermal concentrating systems), and photovoltaic systems.

**Description of
Industry** **Solar building systems** can be passive or active. The passive approach uses a building's structure to capture sunlight and store and distribute heat, reducing the requirements for conventional heating and lighting. Features typically include:

- large, south-facing windows that admit incoming sunlight but trap outgoing infrared radiation;
- tile floors, stone fireplaces, and brick interior walls that store heat from the sun and release it slowly at night;
- simple architectural considerations such as orienting buildings to take maximum advantage of sunlight;
- cooling by ventilating interior spaces, evaporating water, and using the earth to absorb heat; and
- windows, skylights and interior spaces designed to optimize the use of natural light.

Solar collectors are units that collect, store and distribute solar energy for water heating, space heating and space cooling. While most are active systems, using pumps or fans, others are passive, with no moving parts and relying on natural convective forces to circulate hot water or air through the collector. Many types of solar collectors have been developed, the simplest and most popular of which is the flat-plate collector.¹⁰ **Solar water heaters** are a related technology.

Solar thermal concentrating systems can heat water to very high temperatures, making them well-suited for industrial applications (such as the production of metals, glass, cement, paper and brick) and for generating electricity. There are three main types of solar-thermal concentrating collectors: the parabolic trough, parabolic dish, and central receiver. The parabolic trough is a curved reflector that focuses sunlight onto a line receiver, usually a vacuum-enclosed metal or glass pipe, in which a fluid is heated to high temperatures. These collectors are usually mounted on an axis that tracks the sun. A parabolic dish

consists of a bowl-shaped reflector—also on an axis that tracks the sun—that focuses sunlight onto a small receiver through which passes a heat-transfer fluid. In a central receiver system, hundreds or thousands of sun-tracking mirrors, called heliostats, focus sunlight onto a large receiver mounted on a tower. This system generates the highest temperatures of the three.

Photovoltaic cells generate electricity when photons of light knock electrons loose from atoms. The negatively charged electrons and positively charged “holes” are swept onto opposing metal contacts by a voltage created between two semiconductor materials. Closing the circuit establishes an electric current. Individual cells are wired in parallel or in series to provide greater current or voltage, respectively.

Market Potential

Building with Solar Energy

There are encouraging signs of growing interest in passive solar design among buyers, architects, and builders. Some utilities, such as the Sacramento Municipal Utility District in California and Sierra Pacific Power in Nevada, are developing programs to encourage passive solar design as an inexpensive means to reduce their customers' energy use. Nationwide training workshops run by the Passive Solar Industries Council are enjoying a surge in attendance, and federal agencies such as the National Park Service and General Services Administration are participating to find ways to incorporate passive solar design into new buildings.

Solar Buildings. About 250,000 passive solar homes have been built in the U.S., with the number of houses incorporating at least some solar design features (i.e., skylights) much larger. Despite the general economic and aesthetic attractiveness of passive solar designs, they have not been adopted by the construction industry as widely as one might expect. Appropriate building codes, education of architects and construction professionals in solar technology and incentive programs (such as utility-sponsored rebates) are needed to encourage more sensible U.S. energy design. While some existing buildings can be retrofitted with solar features, incorporating solar features during the design and construction phases of new buildings is a less expensive and more effective approach.

Solar Collectors. For lack of market security, the U.S. solar collector industry has had a roller-coaster ride, climbing rapidly in the early 1980s and falling just as quickly with the decline in fossil fuel prices and the end of residential renewable energy tax credits in 1985. Annual sales in the industry have leveled off, and in 1989 there was a slight increase to about 0.6 million square meters (6 million square feet) of collector (both flat-plate and collecting). Most of the more than one million systems that were sold were for heating hot tubs and swimming pools.

In order for solar collectors to play a significant role in the nation's energy supply, federal support must be brought to bear to create a more secure market, so manufacturers' efficiency and overhead costs can be improved. Despite very simple manufacturing requirements (a flat-plate collector consists of little more than sheet metal, copper tubing, glass, and insulation), active solar systems range from about \$1,500 for small **solar water-heating systems** to \$8,000 and up for residential space-heating

and space-cooling systems. A related problem is a lack of long-term financing or leasing options for the systems for homeowners.

Solar-Thermal Concentrating Systems. The potential market for solar-thermal concentrating systems is very large, since some systems can heat sunlight to the very high temperatures needed for industrial applications and for electricity generation. From 1984 to 1990, over 350 MegaWatts of solar-thermal electric capacity in nine solar-thermal plants were installed with private capital in California. Industrial process heat applications (for example, the production of metals) remain a promising but largely untapped market.

It is a matter of some debate whether the parabolic trough technology is truly a viable option for electricity generation in the long term, despite its suitability for low-tech assembly-line construction of very large units. The Department of Energy has in recent years favored parabolic dish and central receiver systems over the trough approach, because of their higher thermal-electric efficiency (a result of the higher temperatures they generate).

Current DOE/industry cooperative plans call for dish-Stirling systems to be produced commercially by 1995 or 1996. Parabolic dish systems are suitable for supplying energy for such industrial applications as the production of metals, glass, cement, paper and brick, as well as for generating electricity at higher efficiencies than are possible with trough systems. However, a key requirement for successful marketing of this technology will be to demonstrate long-term reliability and low maintenance costs.

Central receiver systems continue to be a strong focus in the DOE solar-thermal program. The second generation of this technology in large plants could conceivably make central receivers competitive with conventional alternatives for generating intermediate and peak power.¹¹ Utilities will have to make a large initial investment to reach this level of performance, however, making the commercial prospects of this technology highly uncertain.

Photovoltaic Systems. The photovoltaic industry, while still small at a little over 70 MegaWatts of annual sales worldwide, is growing at a rate of 15 percent per year.¹² Currently, about 60 percent of U.S. photovoltaics sales are for export. They are used in everything from satellite power systems, to tiny solar cells for wristwatches and calculators, to kilowatt-scale systems for remote and specialized power applications.

The largest market for photovoltaic cells now is providing power for equipment and communities far from utility grids, frequently villages in less-developed countries. In addition, long-term prospects for residential applications appear bright, since photovoltaic systems are simple, require little or no maintenance, and pose no unmanageable safety hazards.

In the U.S. and other industrialized countries, the most important new markets for photovoltaic systems in the near term will probably be medium-sized (100-500 kW) power stations designed to reduce peak demand for conventional power and smaller systems for grid-connected homes and businesses.

For example, PG&E, the major supplier of electricity in northern California, has found that photovoltaic systems are cost-effective today in areas where they serve to reduce peak loads on transmission and distribution networks that must otherwise be upgraded at considerable cost.

Photovoltaic cells are positioned for a future as a viable, environmentally sensitive energy source and a product with an established international market. Currently though, despite cost decreases of 60 percent to 90 percent over the past decade, photovoltaic cells are still too expensive (by conventional measures) to make a major impact in the electricity market. Substantial cost reductions will be needed before photovoltaic electricity begins to penetrate the bulk electricity market, but there is every reason to think this goal can be met, if sufficient investments are made in research and development. Cell costs are expected to drop further with additional improvements in technology and economies of scale.

Moreover, the industry holds realistic potential for spawning multiple other industries in the future, such as cars powered by renewable hydrogen or electricity provided by low-cost renewable sources such as photovoltaic cells.

Job Creation Potential

A great variety and number of professional, trade and skilled labor positions are created by the solar industry, with education requirements ranging from high school diploma upwards. Jobs are created in:

- design of solar systems and their production processes (engineers, programmers);
- manufacturing of collectors, photovoltaic modules and other system components (plant managers, light production workers,

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assembly workers, foundry workers, clerical and other office workers);

- installation and maintenance of photovoltaic and water heating systems;
- construction and operation of central plants (architects, contractors, construction workers, plumbers, electricians);
- transportation (truckers, railroad personnel and shippers for domestic and overseas distribution); and
- marketing and retailing (sales, finance, service and warranty. These jobs are community-based, involving house calls and local repair in residential neighborhoods).

The photovoltaic cell industry, for one example, directly employed 1,558 workers and indirectly generated another 1,285 jobs in 1990.¹³ If the Department of Energy's (DOE) year 2000 target of 400 MegaWatt annual production is met, photovoltaics would provide direct and indirect employment of 23,100 people (not including jobs associated with producing other components of photovoltaic systems or with installing or exporting them). Moreover, this market expansion will open the door for greater efficiencies through economies of scale, which will lead to further expansion.

One photovoltaics company interviewed employs up to 90 people, utilizes a 5,000 square foot manufacturing facility, and has seven offices, producing per year.

Many indirect jobs are created in solar component manufacturing. Solar water heater components, for example, require tasks such as metal stamping, metal pipe formation, creating castings for pumps, and manufacturing of glass sheets and rolls of insulation. Many of these jobs require skilled labor; some are low-skill.

Solar collectors are also an energy-efficient, environmentally sensitive technology with great promise to create substantial numbers of career jobs. At a potential of 10 million collectors per year at 400 pounds per collector, the solar industry would require 100 assembly lines nationwide.

**Environmental,
Health and
Safety Issues**

Solar power systems generate no pollution during operation. Moreover, jobs in the solar industry generally involve less overall health and safety risk than conventional energy industry jobs like coal and uranium mining.

The primary environmental, health, and safety issues revolving around solar systems relate to how they are manufactured, installed, and ultimately disposed of. First, energy is required to manufacture and install solar components, and any fossil fuels used for this purpose will generate emissions.¹⁴ Also, the manufacturing of photovoltaic cells can require hazardous materials such as arsenic and cadmium, although there are some cells manufactured today without hazardous substances. Silicon, a major material used in solar cells, can be hazardous to workers if it is breathed in as dust. There is an additional—probably very small—danger that hazardous fumes released from photovoltaic modules attached to burning homes or buildings could injure fire fighters. However, none of these potential hazards is much different in quality or magnitude from the innumerable hazards people face routinely in an industrial society.

The large amounts of land required for certain solar applications, such as central station power plants, may pose a problem in some areas, especially where wildlife protection is a concern. Solar-thermal power plants (like most conventional power plants) typically require cooling water, which may be costly or scarce in desert areas.

Site Potentials

Still, solar energy generated at other California sites offers great long-term potential to supply U.S. energy demand; solar collectors covering less than 1 percent of U.S. territory could make more energy available than the United States consumes in a year. This technology uses a practically limitless resource and has the potential to provide substantial environmental benefits. Making extensive use of solar designs in new building construction—when coupled with efficiency measures such as insulation and low-emissivity (low-e) glass—could reduce demand for fossil fuels by as much as 60 to 80 percent over the long term.

**Infrastructure
requirements**

Given current technologies, a central solar power station may not be feasible at all northern California former military bases, given climatic factors and the large space requirements for the collectors. However, other solar energy industry applications are appropriate for these sites in terms of employee skill level needed, infrastructure required, labor pool size, and the desire for career positions with opportunity for advancement. The manufacture of much of the solar equipment described above—solar water heaters, solar collector panels, solar thermal concentrating systems and photovoltaic cells—could make use of existing infrastructures at shuttered northern California military installations.¹⁵

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Solar Energy Companies, Agencies and Associated Organizations

While the job creation potential of solar energy for the area is large, current market barriers make it likely the industry will not come into its own before 2000. Siting solar companies at closing bases should therefore be planned on a long-term horizon.

Immediate business opportunity

Al Panton, Kyocera America, Inc. Solar Division, 8611 Balboa Avenue, San Diego, CA 92123, 619-576-2647, 619-576-2600, 800-537-0294. 6 employees, established in 1983, annual revenues about \$5-\$10 million. Manufacturer of photovoltaic solar electric modules. The Japanese firm Kyocera America is very interested in opening a solar manufacturing facility in the United States.

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ABB Impell Corporation, P.O. Box 5013, San Ramon, CA 94583. Anthony Zavanelli, 510-275-4521. 1,600 employees. Engineering consultants.

Aero Vironment, Inc., 222 East Huntington Drive, Suite 200, P.O. Box 5031, Monrovia, CA 91016. Dale Foster, 818-357-9983. 130 employees. Provides environmental, transportation, and renewable energy consulting, engineering, and research services. Specialty areas include air pollution, hazardous waste management and atmospheric monitoring; energy efficient vehicles, fluid dynamics; wind and solar energy projects.

Avenida & Associates, Inc., 840 Hinckley Road, Suite 226, Burlingame, CA 94010. Ronnie Avenida, 415-692-4802. 4 employees. Distributor of energy related products; solar systems and related products, lamp reflectors, and catalytic converters.

Borrego Solar Systems, P.O. Box 1565, Borrego Springs, CA 92004. Dr. James Rickard, 619-767-3776. 2 employees. Engineers and installation of photovoltaic electrical systems - consulting, C46 contractor.

California Micro Utility, Inc., 1195 Park Avenue, Suite 202-A, Emeryville, CA 94608. Richard C. Rodgers, 510-658-1273. 2 employees. Engineering services and software for analysis and design of solar thermal, photovoltaic, thermal storage, and monitoring of electric and thermal power.

EN-EX, P.O. Box 365, San Dimas, CA 91773. Shiva Desai, 714-599-7911. 2 employees. Involved in technology transfer of alternative energy. Technology renewable resource conservation and energy management and utility demand-side management strategy.

Energy Line Systems, 2065 Kittredge Street, Suite A, Berkeley, CA 94704. Ronald Hoffman, 510-644-8182. 35 employees. Microprocessor-based, programmable controls, data acquisition systems, and network products.

Energy Resources International, 710 Mission Avenue, San Rafael, CA 94901. Guy Phillips, 415-721-7183. 18 employees. Develop international private power projects. Provide energy and environmental consulting services to public and private clients in international energy project development and finance, international trade, strategic energy planning, and demand forecasting. Engineering and financial feasibility studies, benefit/cost analysis, economic impact analysis, and financial engineering.

Energy Systems Specialists, 250 Main Street, Placerville, CA 95667. Michael Mulcahy 916-626-1454. 1 employee. Solar electric systems - remote homes. Gas refrigeration, DC refrigeration, commercial lighting, small hydro systems, inverters.

***continued,
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centrating Systems
and Photovoltaic Cells***

George Hoffman, ScD, CCA, 130 Marguerita Avenue, Suite 2, Santa Monica, CA 90402. George Hoffman, 310-394-7943. Consulting photovoltaic engineer, cost/risk/failure analysis, design for success/profit.

Heliotrope General, 3733 Kenora Drive, Spring Valley, CA 91977. Sam Dawson, 619-460-3930. 25 employees. Manufacture differential controls for solar thermal pool heating and charge controls for solar electric.

Horizon Industries, 2120 Mission Road, Suite L, Escondido, CA 92029. Mike Landry, 619-480-0403. 12 employees. Solar thermal collector and active hot water system components.

Independent Energy Producers Association, 1001 G Street, Suite 103, Sacramento, CA 95814. Jan Smutny, 916-448-9499. Trade association. Membership companies are involved in all technologies.

Ken Highfill, Inc., P.O. Box 334, Cayucos, CA 93430. Ken Highfill, 805-995-2150. Complete system photovoltaics and thermal; remote, industrial, commercial, residential. Hands on workshops.

Lewis & Associates, 1998 Las Encinitas Court, Los Gatos, CA 95030. Sheri Lewis, 408-370-7261. 1 employee. Management/marketing and financial services for the solar industry.

Lodestone Engineering, P.O. Box 981, Laguna Beach, CA 92652. Dave Wetzel, 714-494-6340. Solar water distillation and desalinization.

Mohr Power Solar Service Centre, 109 Maple Street, Unit D, Corona, CA 91720. Mike Mohr, 714-961-1000. Solar contractor, photovoltaics, and hot water.

Morgan Grenfeld Capital Finance, 505 Montgomery Street, Suite 1200, San Francisco, CA 94111. Tom Webber, 415-788-0255. Project financing for gas/coal plants, solar, thermal, wind, cogeneration, and photovoltaic independent production. Possibly geothermal and hydro if big enough.

North Coast Solar Resources, 1468 Funston Drive, Santa Rosa, CA 95407. Brian Hines, 707-575-3999. 1 employee. Energy service company: design, build, own, and operate alternative energy systems financed through Energy Service Agreements with host site.

Philadelphia Gear Corporation, 24671 La Plaza, Suite 227, Dana Point, CA 92629. George Meyers, 510-676-4694. 300 employees. Manufacturer of a broad range of industrial power transmission equipment, including; cooling tower drives, gear reducers, high speed transmissions, engineered products, and variable speed/soft-start drives.

RCF Enterprises, 27865 Rosamond Drive, Canyon Country, CA 91351. Rick Fee, 805-251-4960. 6 employees. Manufacturer of aluminum support frames for solar thermal collectors and photovoltaic modules.

Real Goods Trading Corporation, 966 Mazzoni Street, Ukiah, CA 95482. Jeff Oldham, 800-762-7325. 60 employees. Supplier of the world's largest selection of alternative energy products.

Renaissance Systems, 5700 Fair Oaks Boulevard, Carmichael, CA 93608. Dr. John Balachandra, 916-972-9411. 2 employees. Energy consulting; power systems, alternate energy systems.

S.A.M., 18287 Maybert Road / Box 70, Washington, CA 95986. Karl Stewart, 916-

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continued, Solar Thermal Con- centrating Systems and Photovoltaic Cells

265-5936. 4 employees. Publish a catalogue for direct mail sales of renewable energy products and other items. Included in their catalogue are solar thermal, photovoltaics, hydroelectric, and conservation products.

Scholfield Solar, 2450 Channel Drive, Suite A, Ventura, CA 93003. Allen R. Carrozza, 805-653-0797. 4 employees. Alternative energy services including domestic and commercial hot water design and installation, photovoltaics design and installation, energy efficient home and office construction, and site surveys and project management.

Science Applications International Corporation, 10340, Roselle Street, Suite G, San Diego, CA 92121. Roger Davenport, 619-546-5787/5791. 12,000 employees. Over \$100 million annual revenue. Manufacturer and developer of advanced solar concentrators and system. Solar heliostats, dish concentrators, and photovoltaic dish concentrator systems. Analysis, design, and implementation of commercial and utility-scale battery storage systems.

Solar Connection, P.O. Box 1138, 1600 N. Main Street, Morro Bay, CA 93442. Michael Orians, 805-772-8601. 3 employees. Remote home photovoltaic power systems; solar water heating systems.

Solar Depot, Inc., 61 Paul Drive, San Rafael, CA 94903. Anoosh Mizany, 415-499-1333. 15 employees. Wholesale-distributor for solar energy equipment (photovoltaics and thermal).

Solar Depot-Sacramento, 8605 Folsom Boulevard, Sacramento, CA 95826. Roy Mizany, 916-381-0235. 6 employees. Wholesale-distributor for solar energy equipment (photovoltaics and thermal).

Solar Electric Engineering, Inc., Gardena (Los Angeles County), California. Gary Starr, 50 employees. Produce line of electric vehicles, both conversions and OEMS. Also distribute solar electric systems.

The Solar Energy Company, Inc., 1216 State Street, Suite 604, Santa Barbara, CA 93101. Christopher Farley, 805-962-8898. 5 employees. Solar hot water heating, marketing and installation; pools, spas, domestic hot water and catalytic water conditioning.

Solar Engineering Applications Corp., Sunnyvale, California. William Lapson, president. Produces a solar panel smaller than conventionals that delivers as much electricity at one-third the production cost (\$100 per watt).

Solartrope, 739 W. Taft Avenue, Orange, CA 92665. Dory Mowlavi, 714-637-6226. 5 employees. Solar, energy conservation, and environmental products, distributor.

Sun Pirate, 22 Varda Landing, Sausalito, CA 94965. Roger Coghlan, 415-332-7246. HVAC/solar contractors.

Sun Works of Fresno, 1421 N. Clovis, No. 105, Fresno, CA 93727. Mike Swieso, 209-252-9552. 5 employees. Engineering and installation of large scale hot water systems; extensive experience in high rise buildings.

Sungry, 623 East Merced Street, Fowler, CA 93625. Dick Kramer, 209-834-3487. 1 employee. Professional engineer, M.E. and agricultural engineer, equipment design and engineering, construction guidance, and inspection for energy conservation and renewable energy systems.

Technetics, Inc., 1100 A North Magnolia, El Cajon, CA 92020-1698. Kick Keplinger, 619-444-9488. 65 employees. Build electronic control devices and

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systems; and also specialize in portable test and calibration devices for such control systems.

V & S International Ltd., 842 Camden Avenue, Campbell, CA 95008-4102. Steve Volek or Thomas Volek, 408-866-6699. 5 employees. Electrical systems components/power systems development (photovoltaic-hydro).

Applied Solar Energy Corporation, 15251 E. Don Julian Road, City of Industry, CA 91746. Dr. Joseph Capitano, 818-968-6581. 85 employees. Solar cell and panel manufacturer, electrical generating systems, control electronic, measurement testing devices, system installations, system design engineering, business technical consultants, and marketing export services.

Archer Solar, 2739 Via Orange Way, Suite 109, Rancho San Diego, CA 91978. Tim Loveall, 619-464-9807. 8 employees. Solar collectors for residential hot water and space heating. Solar thermal systems, consulting and design.

Augustyn & Company, 1029 Solano Avenue, Suite C, Albany, CA 94706. James Augustyn, 510-525-0464. Consultant to utilities, government, and business in solar energy and energy conservation.

Blue White Industries, 14931 Chestnut Street, Westminster, CA 92683. Robin Gledhill, 714-893-8529. 50 employees. Flow meters for solar installations.

Brown & Caldwell, 16735 Von Karman, Suite 100, Irvine, CA 92714-4918. Joel Cross, 714-660-1070. 900 employees. Consulting services, including central heating and cooling systems, thermal storage, and cogeneration systems.

BSAR Solar, 980 Santa Estella, Solana Beach, CA 92075. Joanne Butler, 619-259-8864. 3 employees. Solar hot water heater and distillation systems for homes.

BW/IP International, 200 Oceangate, Suite 800, Long Beach, CA 90802-4335. Tom Ferguson, 310-436-0500. 100 employees. Semi-axial hydraulic turbines for small hydro sites and pumps for geothermal, cogeneration, and solar applications.

Donley & Associates, 1516 Northwest Avenue, Fresno, CA 93728. W. L. Donley, 209-442-1516. 5 employees. Designers of cogeneration systems, energy management systems, and thermal energy storage systems.

E-Tech California, 3010 Coronado, No. H, Anaheim, CA 92806. Vasant Agarwal. Heat pump water heaters.

Fafco, Inc., 2690 Middlefield Road, Redwood City, CA 94063. Freeman Ford, 415-363-2690. 60 employees. Solar panels for residential hot water heating and thermal.

Gull Industries, 2127 S. 1st Street, San Jose, CA 95112. Mike Kennedy, 408-293-3523. 6 employees. Flat plate solar collectors for space and pool heating, and hot water.

Heliodyne, Inc., 4910 Seaport Avenue, Richmond, CA 94804. Christel Bieri, 510-237-9614. Manufacturer of solar collectors, heat transfer equipment, and complete systems for water, home, pool, process water heating and solar cooling with absorption chillers. Residential and commercial.

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continued, Solar Thermal Concentrating Systems Only

Keniston/Mosher Architects, Inc., 1430 Union Street, San Diego, CA 92101. Stanley Keniston, 619-231-1312. 10 employees. Architecture, planning, energy conservation systems; analysis and design.

Laing Thermotech, Inc., 632 Marsat Court, Chula Vista, CA 91911. C. Grgurich, 619-575-7466. 40 employees. Manufacturer of small circulating pumps for hot water recirculation/water conservation.

McCracken Solar Company, 329 W. Carlos, Alturas, CA 96101. Horace McCracken, 916-233-3125. Solar distillation manufacturer.

Morley Manufacturing, Inc., P.O. Box 1540, Cedar Ridge, CA 95924. Bob Pelton, 916-477-6527. Manufacturer of solar drainback storage tanks from 60 gallons to 1,000 gallons.

North Star Company, Inc., 14912 South Broadway, Gardena, CA 90248. Robert Lichtsinn, 213-770-8000. 57 employees. The manufacture of copper fin/tube assemblies for solar absorber plates.

Phenix Heat Pump Systems, Inc., 8390 Gerber Road, Sacramento, CA 95828. Jerry Best, 916-689-8111. Manufacturer of thermal storage heat pump systems.

Professional Solar Installations, 6922 Geyser Avenue, Reseda, CA 91335. Guy Donahue, 818-708-3683. Solar thermal water heating, space, domestic, pool, and greenhouse heating.

RM Banks & Associates, 999 West Cutting Boulevard, Suite 7, Point Richmond, CA 94804. Ridgway Banks, 510-237-0609. 2 employees. Development of low-temp solid state energy conversions, heat engines, solar powered pumps, and related technology.

Radco Products, Inc., 2877 Industrial Parkway, Santa Maria, CA 93455. Fred Sanders, 805-928-1881. 25 employees. Manufacturer of Radco Solar Collectors (flat plate) and Radco drainback heat exchange modules.

Smith and Sun, 612 Euclid Avenue, Berkeley, CA 94708. Otto Smith, 510-525-9126. 2 employees. Solar designs: cooking, space heating, industrial hot water, solar-thermal-electric power plants, high efficiency motors.

Solar Box Cookers International, 1724 11th Street, Sacramento, CA 95814. Beverly Blum, 916-444-6616. Portable lightweight solar cookers for household use.

SunEarth, Inc., 4315 Santa Ana Street, Ontario, CA 91761. Arthur Brooks, 909-984-8737. 11 employees. Manufacturer of flat plate thermal solar collectors and manufacturer of Integral Collector Storage (ICS) solar water heaters.

Sunshine Systems, 14340 Dandee Hill Road, Grass Valley, CA 95945. Dan Conroy, 916-272-5457. 12 employees. Manufacture passive solar water heating appliances, 12-24 volt super efficient refrigerators and freezers.

Sunstream, Inc., 998 San Antonio Road, Palo Alto, CA 94303. Allen Bronstein, 415-

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494-9144. Manufacture, install, and services; parabolic trough concentrating collectors.

Turbulence Tubes, 544 South Pacific, D-100, San Marcos, CA 92069. Joanne Butler, 619-471-5252. 4 employees. Solar hot water heater/distillation systems for home use.

United Solar Technologies, 1425 Brommer Street, Santa Cruz, CA 95062. Carlo Laporta, 408-476-3856. Produce parabolic trough solar thermal energy systems, develop projects, raise capital, negotiate energy sales contracts, perform market studies.

VEDA, Inc., 1345 Grand Avenue, Oakland, CA 94610. Mark Sutton, 510-444-6152. Solar energy applications and industrial solar power system design.

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A.N. Williams & Associates, P.O. Box 492, Bonsall, CA 92003. Nash Williams, 619-728-3574. 3 employees. Design and analysis of photovoltaic systems. Technical consulting.

Alternate Energy Institute, 5333 Mission Center Road, Suite 351, San Diego, CA 92108. M. Collins or M. Learn, 619-692-2015. 3 employees. Solar energy research and education, photovoltaic systems development and marketing.

Carbone Investment Management Company, 7390 Creston Road, Paso Robles, CA 93446. Robert Carbone, 805-239-2876. Investment adviser/financial consultant to photovoltaic industry.

Diversified Services for Africa, P.O. Box 1081, Berkeley, CA 94701. Kwablah Attiogbe, 510-849-9409. 2 employees. Marketing of solar-powered lighting systems to Africa.

Earthlab Energy Systems, 358 S. Main Street, Willits, CA 95490. David Leverett, 707-459-6272. 6 employees. Develops, manufactures, and markets energy products, development of remote free-standing renewable energy systems and solar farms.

Echo Energy Products, 219 Van Ness Avenue, Santa Cruz, CA 95060. George Hug, 408-423-2429. Photovoltaic systems, mounts, and components, prepackaged and modular.

Energy Specialists, P.O. Box 188710, Sacramento, CA 95818. Donal Luthringer, Jr., 916-392-7526. 1 employee. Solar electric systems - remote homes. Gas refrigeration, DC refrigeration, commercial lighting, small hydro systems, inverters.

Global Light and Power, 55 New Montgomery Street, Suite 424, San Francisco, CA 94105. Steve Van Ronk, 415-495-0494. International distribution of renewable energy systems. Actively developing educational programs to present internationally, including video production and simplified technical overviews and demonstrations.

Integral Energy Systems, 109 Argall Way, Nevada City, CA 95959. Jonathan Hill, 916-265-8441. 4 employees. Remote power systems for the home, photovol-

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continued,
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Only

taics, solar hot water, micro-hydropower, energy conservation.

International Solar Development, 600 15th Street, Newport Beach, CA 92663. James Duncan, 714-650-7042. 2 employees. Mobile solar power station manufacturer. Solar electrical systems design and installations.

International Technology Group, 58 Oakdale Avenue, San Rafael, CA 94901. Dietrich Grabis, PhD, 415-454-8054. 8 employees. Engineering and marketing of alternative energy systems: photovoltaics, linear concentrating collectors, total system approach and biomass systems.

Kyocera America, Inc. Solar Division, 8611 Balboa Avenue, San Diego, CA 92123. Al Panton, 619-576-2600. 6 employees. Manufacturer of photovoltaic solar electric modules.

L M Dearing Associates, Inc., P.O. Box 1744, Studio City, CA 91604. LeRoy Dearing, 818-506-7701. 2 employees. Engineering, manufacturing, and sales of solar pool covers and reels for commercial swimming pools; design and marketing of solar thermal and photovoltaic systems.

Market Research International, P.O. Box 1028, Sierra Madre, CA 91025. Mike Randall, 818-355-0756. 4 employees. Architectural and solar marketing, analysis, and design.

National Energy Research Corporation, 1711 Whittier Avenue, Costa Mesa, CA 92627. Val Kanaga, 714-645-2720. 161 employees. Manufacturer of electric energy saving products (i.e. lighting, HVAC, etc.)

Photocomm, Inc., 930 Maryland Road, Grass Valley, CA 95945. Sam Vanderhoof, 800-544-6466. 75 employees. Full service photovoltaic systems marketing organization.

Polar Products, Inc., 2808 Oregon Court, K-4, Torrance, CA 90503. Nancy Cohn, 310-320-3514. 16 employees. Solar refrigerators for vaccine storage, solar control electronics.

Siemens Solar Industries, Inc., 4650 Adhor Lane, Camarillo, CA 93011. Mark Stimson, 805-482-6800. 400 employees. \$25-\$100 million annual revenue. World leader in the development and manufacture of photovoltaic solar electric products.

Solar Electric Specialties Company, P.O. Box 537, Willits, CA 95490. Wayne Robertson, 707-459-9496. 24 employees. One of the largest photovoltaic system integrators in the world.

Solar Trade International, 630 6th Avenue, San Francisco, CA 94118-3805. Manuel Blanco, 415-386-4117. 2 employees. Engineering consulting firm specialist in photovoltaic technology R&D and international technology transfer. American-European energy business development and international technology transfer.

Solec International, Inc., 12533 Chardron Avenue, Hawthorne, CA 90250. Jawid Shahryar, 310-970-1065. 65 employees. Manufacturing photovoltaic cells, modules, and systems; technology transfer.

Specialty Concepts, Inc., 9025 Eton Avenue, Unit A, Canoga Park, CA 91304-1620. Tom Philip, Marketing Manager, 818-998-5238. 16 employees. Manufacturer of photovoltaic charge regulators.

Strategies Unlimited, 201 San Antonio Circle, Suite 205, Mountain View, CA 94040. Robert Johnson, 415-941-3438. Worldwide market research and consult-

continued,
Photovoltaic Cells
Only

ing in photovoltaics.

Sun Frost, P.O. Box 1101, Arcata, CA 95521-1101. Larry Schlusser, PhD. Owner, 707-822-9095. 24 employees. Energy efficient DC refrigerators for domestic use and vaccine storage.

Touchstone Technology, 17500 Lemarsh Street, Northridge, CA 91325. Paul B. Scott, 818-993-9871. Solar water pumps.

Trojan Battery Company. Contact: Jim Drizos, 1-800-423-6569.

United Solar Systems Corporation, 5728 Eastgate Mall, San Diego, CA 92121. Pam Bird, 619-625-2080. 130 employees. Manufacturer of photovoltaic modules, RV, marine, and home power kits.

Utility Power Group, 9410-G De Soto Avenue, Chatsworth, CA 91311. Michael Stem, 818-700-1995. 8 employees. Manufacturer of photovoltaic cells, modules, and power systems.

Interviews &
Sources

Jean Bertsche, employee at a photovoltaics manufacturer, 800-544-6466

Cool Energy, 1992, Michael Brower, published by The MIT Press, Massachusetts Institute of Technology, Cambridge, MA 02142

Energy Source Directory, 1993 Edition, by Iris Communications

1993 Energy Technology Export Directory, California Energy Commission, Sacramento, CA

Environmental Impacts of Renewable Energy Technologies, Briefing Paper, Union of Concerned Scientists, 26 Church Street, Cambridge, MA 02238, 617-547-5552

"Jobs Benefits of Expanding Investment in Solar Energy", pp 17-25, fourth quarter 1992, volume 3, issue 4, Solar Industry Journal, Solar Energy Industries Association, 202-408-0660

"Tomorrow's Energy Today", pp 58-72, *Audubon* magazine, January 1990

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

**Type of Industry/
Business** Fuel cell manufacturing

**Description of
industry/
technology**

Fuel cells are a highly promising alternative energy source. They are used both in electricity production and to supply energy for transportation. The following discussion focuses on manufacturing of fuel cells for power plants. (Please see the Advanced Transportation section for more on that market segment.)

With increasingly stringent regulations on power plant exhaust emissions, cleaner methods of electricity production—such as fuel cells—are becoming more desirable in the marketplace. Current generation fuel cells are not technically a renewable energy source, since they do consume fossil fuel. But eventually they could be run on pure hydrogen. And their clean and efficient conversion of fossil fuel to energy puts them outside the class of conventional fossil fuel power production.

At present there are several fuel cell power plants in operation in the United States which are in the demonstration or commercial prototype stage. By the end of 1994, 27 such power plants are scheduled to be in operation, eighteen of these in Southern California.¹⁶ Another is expected to begin operation in the city of Santa Clara this year.

The reasons for this interest are simple; exhaust emissions from an operating fuel cell are a fraction of those from a conventional fossil fuel power plant, ranging from zero to a few parts per million of carbon monoxide, nitrogen oxides, and total hydrocarbons. Carbon dioxide emissions are roughly one-half or less of those from conventional fossil fuel power plants. Moreover, the high efficiency¹⁷ at which fuel cells operate allow power to be generated using less fuel, having the combined effect of decreasing pollution and providing the power at a lower cost to the market.

Additional advantages of fuel cells are that they can be produced in small sizes and they are quiet. This allows power plants to be sited where the energy is required—such as in urban areas—alleviating the need for costly transmission lines and eliminating the power losses associated with long distance transmission. If fuel cell technology were widely adopted as an energy source, it could reduce the need to develop other energy sources (new nuclear power plants or hydroelectrical dams, for example) with more negative environmental impacts. However, fuel cell production requires the use of solvents, heavy metals and acids.

Fuel cells are incorporated into power plants which are designed to take in raw fuel and oxidant and deliver electrical power to customers. Fuel may consist of natural gas, coal-gasified fuel, or hydrogen as well as other alternatives. Air is generally used for the oxidant.

A fuel cell operates in a manner similar to a conventional battery. An electrochemical reaction occurs at one electrode which releases electrons, while another reaction occurs at an opposite electrode which absorbs electrons. Fuel cells differ from batteries in that the components of the reactions at each electrode are supplied by gaseous fuel and oxidant which is passed over these electrodes. In a battery, the electrodes themselves are the reactants and thus become "exhausted" and must be replaced periodically. In a fuel cell, the reactions continue as long as fuel and oxidant are present at the electrodes.

After about five years of operating life the fuel cell power section must be rebuilt because the catalyst is worn out. Much of the original material can be recycled, and the material which cannot be recycled must be disposed of along with the manufacturing process scrap materials.

Because the fuel cell reactions are electrochemical, the chemical energy of the fuel is converted directly to electrical energy without the intermediate conversion to mechanical energy. (It is this conversion to mechanical energy in the combustion step of conventional fossil fuel power production that limits efficiency and generates high levels of pollutants —sulfur dioxides, nitrogen oxides, hydrocarbons, carbon monoxide and carbon dioxide.)

The products of the fuel cell reaction are electricity, heat, water and carbon dioxide, although trace amounts of other pollutants such as nitrogen oxide, nitrogen dioxide, carbon monoxide, and light hydrocarbons may be produced depending on the fuel cell power plant design. The water and heat produced from the fuel cell reaction may be recovered for useful purposes, further increasing the efficiency of the entire power plant operation.

There are several different types of fuel cells, named after the electrolyte they use. Phosphoric acid fuel cells, molten carbonate fuel cells, and solid oxide fuel cells are three types which are in use or in development for the energy industry. Alkaline fuel cells and proton exchange membrane (or solid polymer electrolyte) fuel cells are types which are not presently being developed for the energy industry, although they may be in the future.

Practically all of the currently operating fuel cell power plants in the world utilize Phosphoric Acid Fuel Cells. These power plants generally run on natural gas or naphtha for fuel and range in size from several kilowatts to several megawatts. Electrical efficiencies for these power plants run up to roughly 45 percent, compared with a maximum of approximately 34 percent for conventional fossil fuel power plants.

Molten Carbonate Fuel Cell power plants are being developed and sited. These power plants will run on natural gas or coal gasified fuel and will range in size from a few megawatts to hundreds of megawatts. Electrical efficiencies from these power plants can be as high as 60 percent, providing a distinct advantage over phosphoric acid fuel cells.

Solid Oxide Fuel Cells are being developed for future applications in the energy industry. The efficiency of the solid oxide fuel cell (roughly 50 percent) is lower than that of the molten carbonate fuel cell.

Market Potential

The fuel cell market is immature but enormously promising. As fuel cell power plants establish a performance record, the fuel cell market is likely to expand tremendously. Areas where urban siting, air quality, and other drivers are of high priority are leading the way in overcoming this barrier by demonstrating the technology.

It is difficult to project the numbers now for the market potential for fuel cells in the northern California area, but several factors are drivers for fuel cells becoming significant in the energy production market. As the region's population increases, the demand for energy will certainly increase. With the public and political pressure to move to cleaner sources of energy, which may include closing down presently active nuclear and fossil fuel power plants, fuel cells become a good alternative and addition to the energy production infrastructure. With the availability of natural gas, of which there are no projected shortages in our domestic supplies, the fuel supply infrastructure for fuel cells already exists. Both the gas and electric utility companies in the area can only benefit by providing cleaner, less expensive energy to their customers.

Fuel cells produced in any one location can be marketed worldwide, therefore the market of a fuel cell production effort is the entire world market.¹⁸ Fuel cell power plants can provide a significant portion of the of the growth in the energy field in the future, as the demand for energy increases with increasing population. Fuel cells can also replace the present technologies which are relatively dirty and inefficient and therefore will become more expensive as fuel prices rise and as energy production must begin being accountable for its own pollution.

The customers of fuel cell power plants vary dependent on the size of the power plant. The electric utility industry, such as Southern California Edison, are interested in the larger power plants ranging in size from around one megawatt up to several hundred megawatts. These plants would either be sited in urban areas close to the point of demand (smaller power plants), or sited adjacent to fossil fuel power plants or industrial sites to take advantage of co-generation schemes (larger power plants). These power plants would be used to generate power at maximum capacity or to meet peak power demands during busy times of the demand cycle.

The gas utility industry, such as Southern California Gas, and large private customers (hotels, hospitals, office buildings, apartment buildings) are potential customers for small- and medium-sized power plants of up to one megawatt. Eventually, smaller fuel cells (on the order of several kilowatts) may be produced for single family homes. These mini-power plants could be operated independent of the main power grid, allowing a private customer to produce its own electricity to meet the load demand of a building.¹⁹ In addition, any excess electricity produced could be sold back to the electric utility for a profit.

Job Creation Potential

Fuel cell manufacturing employment potential is as widely variable as the market potential, with the number of jobs created dependent on the capacity of a given facility. A manufacturing facility with a capacity to produce around fifty 200 kilowatt fuel cells per year could employ between one hundred and two hundred people.

Most of these would be skilled labor jobs (factory floor machine and equipment operators and assemblers) not requiring college education; welders, assembly line and robotics operators, etc. Technical aptitude, such as math skills, could be important. Along with these floor positions, professional level jobs (technicians, engineers, clerks, and supervisors, all typical of a manufacturing operation) would be created. For a staff of two hundred, 5 to 10 percent would be technicians and engineers, 5 to 10 percent clerks and supervisors, 5 percent office staff, and the remainder floor positions.

Environmental, Health & Safety Issues

Environmental concerns related to fuel cells focus primarily on their manufacturing and disposal, since their operation is benign relative to all other fossil fuel energy production (although it is not truly zero emission like solar power and wind power).

The manufacturing of fuel cells involves a variety of operations which have potentially harmful environmental effects. Hazardous materials such as phosphoric acid may be used. Heavy metals such as nickel and

chromium used in certain fuel cell components are hazardous. Manufacturing of certain fuel cells, such as solid oxide fuel cells, is extremely energy intensive. (Further research is needed to review precise anticipated air and water emissions resulting from manufacturing and eventual disposal of fuel cells.)

Despite these caveats, fuel cell manufacturing facilities are all new, fairly state-of-the-art, and are set up with environmental concerns in mind. The potential for an extremely clean manufacturing technology exists.

The safety issues related to the operation of a fuel cell power plant are those for any device which has a combustible gas fed to it and running at an elevated temperature and high voltage; danger of fire and injury to persons in contact with these hazards. This is not much different than having a gas stove in your kitchen, an electrical box in your basement, or, at worse, a gas station on the corner of your block.

Infrastructure Requirements

The infrastructure requirements for a fuel cell manufacturing facility would be similar to those for other light industrial operations. Comparable (fairly high) levels of power would be required. Electricity requirements could in theory be met by actual on-site fuel cell power plants, a self-contained promotional model for the product.

Raw materials required for the manufacturing operations should be as readily available as they are where the current facilities are (primarily on the East Coast) although this is not certain.

In many respects the fuel cell manufacturing industry could be a good fit for bases near dense urban areas, such as Hunters Point or Alameda. A Hunters Point location would put a U.S. fuel cell manufacturing operation closer to a larger domestic geographic market than any other American operation to date.

Infrastructure problems would probably be minimal. A fuel cell production and/or development facility could move into a vacant manufacturing plant at a closed base, reducing start-up costs.

The availability of skilled laborers in the Bay Area, combined with the availability of qualified technical personnel from closed Bay Area military operations also make the site attractive.

The problems with starting a fuel cell facility are the problems of starting an operation anywhere in California. Stringent regulations, high taxes and relatively high wages are obstacles which could discourage fuel cell manufacturers from other states to move to the site. It is possible that

in the future federal regulations and operating costs elsewhere in the country will rise to a level where it is competitive to open up shop in California, but for now it is not economically viable to set up a manufacturing operation here without significant federal, state and/or local economic incentives.

Fuel Cell Companies, Agencies and Associated Organizations

Advanced Energy Conversion Department, Westinghouse Electric Corporation - 1310 Beulah Road, Pittsburg, Pennsylvania, 15325. solid oxide fuel cells

AiResearch, Allied Signal, Department 35140, 2525 West 190th Street, Torrance, CA 90509. J. Seyster, 310-512-2898. Aerospace/heat transfer, cryogenic systems and fuel cell power generation systems.

American Association for Fuel Cells, Daly City, CA.

Electric Power Research Institute - 3412 Hillview Avenue, Palo Alto, California, 94303. Research and development arm of utility industry

Energy Research Corporation - 3 Great Pasture Road, Danbury, Connecticut, 06813. molten carbonate fuel cell power plants

Gas Research Institute - 8600 West Bryn Mawr Avenue, Chicago, Illinois, 60631.

M-C Power Corporation - 8040 South Madison Street, Burr Ridge, Illinois, 60521. molten carbonate power plants.

ONSI Corporation - Aircraft Road, Middletown, Connecticut, 06457. phosphoric acid fuel cell power plants

International Fuel Cells Corporation - 195 Governor's Highway, South Windsor, Connecticut, 06074. fuel cells which supply the electrical power for the U.S. space shuttles.

Morgantown Energy Technology Center, U.S. Department of Energy - P.O. Box 880, Morgantown, West Virginia, 26505. Government research and development body

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Types of Industry/ Business

High-efficiency appliances and space conditioners
Evaporative cooling air conditioning manufacture/installation
Lighting
Appliances

Description of industry

The use of appliances and heating and cooling equipment costs an average household more than \$1,000 per year. High-efficiency appliances and space conditioning equipment can lower this cost, by reducing energy bills. Even factoring in their higher initial cost, energy-efficient appliances are typically cheaper than conventional models, since the additional purchase price is more than compensated for through reduced energy bills over the life of a product.

In addition to the cost savings, high-efficiency appliances and space conditioning equipment are environmentally beneficial, since they reduce the amount of fossil fuels burned for electricity (thereby reducing greenhouse gas emissions, acid rain and other related environmental problems).

Energy Use in a Typical California Home

The following list shows the average breakdown of energy usage in California

space heating and cooling ²⁰	30%
water heating ²¹	26%
refrigeration ²²	11%
cooking	5%
clothes drying	4%
motors	4%
color TV	2%
lighting	9%
all other uses	9%

Recognizing these benefits, the 1987 National Appliance Energy Conservation Act established minimum energy efficiency standards for major home appliances and heating and cooling equipment. The standards for most appliances took effect in 1990. The standards for central air conditioners, heat pumps, and furnaces took effect in 1992, and revised standards for refrigerators began in 1993. These mandates are encouraging product design changes (larger heat exchangers, higher efficiency motors, more efficient compressors, more computerized controls and variable speed motors) and more efficient appliances.

The American Council for an Energy-Efficient Economy estimates that the stricter energy use standards will save consumers at least \$28 billion over the lifetimes of the products sold through the year 2000, or about \$300 per household. Furthermore, the standards will reduce peak electricity demand by the equivalent of 25 large power plants.

The new standards also create new market opportunities for manufacturers of more environmentally sound appliances, including room air conditioners.²³

Central Air Conditioners - Air conditioners work a lot like a refrigerator. A fan blows air across a cold evaporator coil and then sends this cool air into a house through supply ducts. Warm air is drawn into the return

ducts and sent back to the system to be cooled. A refrigerant takes the heat to the outside unit where it is dissipated in the outdoors.

Central air conditioners are rated according to their Seasonal Energy Efficiency Ratio (SEER). This is the cooling output divided by the power input for an average U.S. climate. The national efficiency standard for central air conditioners took effect on January 1, 1992, requiring a minimum SEER of ten. Many older central air conditioners have SEERs of only six or seven. Today's most efficient models have SEERs ranging from 12.85 to 16.90.

One energy-efficient, CFC-free air conditioning technology is **evaporative cooling**. Cooling by evaporation—using the natural cooling effect of water evaporating into air—has a long history of use as an inexpensive cooling system. The process removes heat from liquid water in order for some of the water to evaporate into the air. Today, air conditioning and general cooling to remove waste heat, such as in cooling towers, are the main uses for this technology.

Desiccant-assisted evaporative cooling allows the use of the evaporative cooling technology in high humidity areas. In these systems, a solid or liquid first absorbs or adsorbs the water out of the air and the dried air then enters an evaporative cooler. Since the air is dry, the cooler works at high efficiencies.

Evaporative cooling air conditioners are far more efficient than energy efficient air conditioners using conventional technologies. Evaporative cooling doesn't use CFCs, provides better indoor air quality by bringing in outside air, and saves substantial amounts of energy. Direct evaporative cooling uses 75 percent less energy and indirect-direct uses 50 percent to 60 percent less energy than traditional energy-efficient vapor compression air conditioning technologies.²⁴ Direct evaporative cooling is used in residences and many commercial industrial installations, such as greenhouses, automotive, telephone switching facilities, gas turbine cooling, spot cooling, relief cooling and laundromats. For humid areas, indirect-direct evaporative cooling has been developed in which a desiccant is used to absorb moisture from the air.

A group of companies in the U.S., United Kingdom and Saudi Arabia are developing a desiccant-assisted evaporative cooling system using lithium bromide. The system has achieved significant energy savings over conventional air conditioning systems.

Lighting. Switching from incandescent to fluorescent lighting saves money and energy because fluorescent is four times more efficient. A

27-watt fluorescent lamp gives off the same light as a 100-watt incandescent lamp. And while their purchase price is much higher than incandescents', fluorescents also last up to 13 times longer, making the lifecycle costs much lower. A 27-watt compact fluorescent bulb saves \$86 in energy costs over the life of the bulb and uses 75 percent less energy, compared to conventional bulbs. Switching from incandescent to halogen lights also saves energy, but not nearly as much as switching to fluorescent.

Appliances. Design changes have dramatically improved the energy-efficiency of refrigerators over the past 20 years.²⁵ A typical new refrigerator with automatic defrost and a top-mounted freezer uses less than 750 kilowatt-hours per year, whereas the typical model sold in 1973 used nearly 2000 kilowatt-hours per year. The most efficient refrigerators are at least 15 percent more efficient than the level required by the new 1993 standard, and range from 496 to 918 kilowatt-hours of energy use per year, depending on volume.

Despite advances in increased energy efficiency, most refrigerators still use HCFC 141B, an ozone-destroying chemical, in insulating foam. Several energy-efficient alternative refrigerants and coolers are being developed which do not use CFCs, HCFC nor HFCs. These include ammonia-based vapor compression (v-c) and absorption systems, water-based evaporative cooling systems, and hydrocarbon-based v-c systems which are already in wide use. Others such as helium-based Stirling cycled systems and zeolite-based adsorption systems are either beginning to enter commercial markets or will in the near term.

Energy-efficient dishwashers and clothes washers, furnaces and boilers, central heat pumps and water heaters are other appliances beginning to gain marketplace acceptance.

(For information on the energy usage of specific brands of energy-efficient appliances, please refer to "The Most Energy-Efficient Appliances 1992-93," a booklet published by the American Council for an Energy-Efficient Economy.)

Market Potential **Evaporative cooling.** Due to regulatory developments and to its adaptability to both dry and humid areas,²⁶ evaporative cooling technology has huge market potential in the U.S.

Over 70 U.S. companies manufacture evaporative air conditioners for residential, automotive, commercial and industrial applications. For example, over 400 public transit buses in the U.S. have evaporative-cooling air conditioning systems and units have recently become available for automobiles. Also, solar-powered evaporative cooling is available for residences.

Four million homes in the U.S. currently use evaporative coolers, making the expanding market for this technology about \$150 million per year. (In El Paso, Texas, the 23rd largest U.S. city, 95 percent of homes and 40 percent of commercial buildings use evaporative cooling.)

In California, multiple agencies are driving this expansion including the California Energy Commission (CEC), U.S. EPA, Sacramento Municipal Utility District, Pacific Gas & Electric and Southern California Edison, which all have programs to promote the technology.²⁷ A California Energy Commission study indicated that indirect-direct evaporative cooling can be used for comfort cooling in all of California, except for a small region in the Southeast. A researcher at New Mexico State University believes direct evaporative cooling is appropriate for the mountain areas of California whereas the indirect-direct and dessicant-assisted methods can be used in valley and muggy areas.

Moreover, the pending U.S. government ban on CFC usage (1996) is expected to cause dramatic changes in the air conditioning industry, and create further market opportunity for evaporative cooling. According to the environmental group Greenpeace, energy-efficient, CFC-free alternatives exist for all major appliances in the refrigeration and cooling sector. For example, helium-based Stirling cycle systems hold great promise in the short- to mid-term. Other technologies such as adsorption systems using zeolite and water, and absorption systems based on ammonia and water are commercially available and becoming more widely used.

It may be that barriers to commercial production/ marketing of these systems are as much a matter of political preferences and subsidies as of technology. Until the external costs of using damaging chemicals and nonrenewable resources are factored in, and subsidies for use of virgin materials are eliminated, appliance efficiency will continue to be primarily driven by legislation and only secondarily by consumers (companies gaining a competitive advantage through energy-conserving products).²⁸

Lighting. The demand for energy-efficient lighting products is on the increase. The market potential is especially strong for commercial and other large-scale applications where dollar savings can be significant. Eager to take advantage of utility rebate programs, Bay Area homeowner associations and apartment owners are also a fertile market for energy-efficient lighting.

Appliances. On the plus side, demand for appliances is relatively inelastic, since many are considered necessities. That is, most consumers will continue to buy appliances even if prices rise substantially.

However, buyers are cost-conscious, with value the main purchase criteria, followed by options and size/capacity. Most customers buy the cheapest brands, frequently the ones with minimum efficiency. And although the higher up-front costs of new, energy-efficient appliances can be offset by lower energy costs, in some cases the payoff can take a long time.²⁹

Another impediment to increased sales of energy-efficient models is the long replacement cycle for many appliances, sometimes as long as 20 to 30 years. Many of these old models are shifted to auxiliary uses, such as a second refrigerator in the garage. The increased market for second-hand appliances could also temporarily slow sales of energy-efficient units; utilities often pick up old appliances for re-use.

Job Creation Potential

Evaporative cooling air conditioning offers significant job creation potential in the near term, given its extensive market potential and support from key California organizations. Moreover, evaporative cooling manufacturing is labor-intensive, requiring hand assembly and small power tool work. Jobs are created in administration, engineering and design, shop/sheet metal working, assembly and shipping/packaging.

A small plant of about 25 to 30 employees could manufacture 60 to 80 units per day (an estimated breakdown of jobs follows). By far the largest number of jobs would be in sheet metal construction, including bending and cutting metal.³⁰

24	laborers
2-3	engineers
1-2	administration
2	shipping
2	truck drivers

While these are not upper-income jobs, many people do make a career of them. Higher salaries are generally earned by shop foremen,

engineers, and administrative staff. Jobs would also be created through installation of evaporative cooling systems.

Lighting. According to an energy-efficient lighting specialist, jobs in energy auditing and implementation of energy efficiency are low-skill. This sort of work does not require a degree, although a basic technical degree would help. Some tasks include using charts and pre-set programs and require good presentation and college-level communication skills.

Environmental, Health & Safety Issues

Appliances. Increasingly stringent minimum efficiency standards will force appliance manufacturers to produce models that minimize environmental impacts. However, many appliances still use CFCs, HCFCs, or HFCs and/or are powered by fossil fuels or other unsustainable energy sources, leaving room for improvement.

For instance, the CFC substitute of choice for major refrigerator manufacturers such as Whirlpool and Maytag is HFC 134A, a chemical which doesn't destroy the ozone layer but does contribute to global warming.³¹ Several alternative refrigeration technologies exist, such as ammonia-based vapour compression (v-c) and absorption systems, water-based evaporative cooling systems, hydrocarbon-based v-c systems, Stirling cycled systems, and zeolite-based adsorption systems.

While these alternatives hold promise as potential environmentally sensitive, cost-effective, efficient substitutes to CFCs, further scientific research is needed to confirm the viability of some options. It must be recognized that few alternatives to ozone-depleting chemicals will be entirely without environmental impact. Only those alternatives which meet the following criteria should be viewed as viable:

- no chlorine- or bromine-containing compounds;
- no compounds which contribute, or are suspected of contributing, to ozone depletion;
- no substances or technologies which may contribute significantly to global warming;
- substantial minimization of energy use; and
- no technologies which use or result in synthetic, persistent, and/or toxic substances.

For these reasons, further exploration of the lifecycle environmental impacts of energy-efficient refrigerators is needed before a recommendation for siting an icebox manufacturing plant at closed military bases can be made.

Energy-efficient lighting audits and implementation of energy efficient lighting have virtually no environmental impacts. (See the residential weatherization section which follows for a discussion of energy audits.)

The majority of residential energy is used in space heating/cooling and water heating, making improvements in these areas an environmental priority. **Evaporative cooling unit assembly** is environmentally "low impact but not no impact." It involves ordering parts and assembling them. While it is not very environmentally destructive, it does involve a sheet metal painting process, such as acid etch. However, the muriatic acid used is easily and cheaply neutralized with baking soda. The painting occurs in a "paint booth," and the process is similar to painting in an auto body shop.

Infrastructure requirements

Evaporative cooling manufacturing resembles sheet metal shop operations. Basically, a single, large warehouse would be sufficient for an evaporative cooling manufacturing plant. Equipment needed includes small power tools, shears to cut metal, brakes to bend metal, drill presses, small welding/soldering equipment and several lathes, if desired.

Evaporative cooling manufacture and installation represents a significant and exciting job creation opportunity at former military bases. Existing labor skill sets and structures may be easily modified to meet the requirements of this industry. In addition, because the manufacture of evaporative cooling air conditioners does not represent a "smokestack" industry, manufacturers might not be deterred by California's stringent environmental requirements. Also, in contrast to immature, newly-emerging industries, evaporative cooling has been demonstrated to be a viable industry with career jobs.

Working directly with organizations currently interested in commercializing the technology (namely, the CEC or Pacific Gas & Electric) is probably the most productive avenue in attracting evaporative cooling manufacturers and installers to closing bases.

The following companies manufacture appliances which use safer alternatives to ozone-depleting chemicals.

**Air Conditioning
Companies,
Agencies and
Associated
Organizations**

**Evaporative
Cooling Systems**

Evaporative Cooling Institute, Southwest Technology Development Institute, New Mexico State University. Robert Foster, 505-646-1846, 505-646-4104. ECI is a clearinghouse for information of evaporative cooling manufacturers and technological developments in the U.S.

ADA Systems, Wood Dale, Illinois. Richard T. Sohr, 708-238-1516

Adobe Air, Phoenix, Arizona. Ron Rosin, Darman Ollson, 602-257-0060

Air and Refrigeration Corporation (ARC), Dallas, Texas. Ronald Yaeger, 214-747-0214

Alton Air Products, Dallas, Texas. Harry Gaffney, 214-941-0505

Arvin Industries, Phoenix, Arizona (also sold through William Lamb, North Hollywood, California) with photovoltaic solar panels. 602-257-0060

Aztec International, Albuquerque, New Mexico. Kenneth B. Beckmann, 800-545-8306

Baltimore Air Coil, Jessup, Maryland. Robert Catef, 410-799-6262

Champion Cooler Corporation, El Paso, Texas. Paul Malooly, 800-588-2665

Convair Cooler Corporation, Denison, Texas. Charles F. Myers, 903-463-7191

Davis Energy Group (DEG), Davis, California. 916-753-1100

Des Champs Labs, Livingston, New Jersey, 201-535-8300

Di Peri Manufacturing Corp., Northridge, California. Leo Di Peri 818-885-0011

Engineered Commercial Concepts Inc (ECCI), Dallas, Texas. William Crum 214-484-0381

Essick Air Products, Little Rock, Arkansas. Joseph Harmon, 501-562-1094

FI Reznor, Mercer, Pennsylvania. Richard Blasko, 412-662-4400, or Thomas and Betts, Memphis, Tennessee, John Garevelli, 901-682-7766

Goettl Enterprises, Phoenix, Arizona. 602-273-7483

Munters, Fort Meyers, Florida. Ms. Pat Thomas, 813-936-1555

Norsaire Systems, Denver, Colorado. Dr. John Kinney, 303-937-9595

Pnumofil Corp., Charlotte, North Carolina. Wayne Cuthbertson, 704-399-7441

Rey Industries, Boise, Idaho. Robert E. Yearsley, 208-336-4821

Spec-Air, Canutillo, Texas. Stephen L. Callahan, 915-877-3136

Sprinkool Systems Inc, Killen, Alabama. Charlotte Balentine, 205-757-5366

Univ. Arizona Environmental Research Laboratory / Planetary Design Corp., Tuscon, Arizona. 602-294-4808

University of California / Sacramento Municipal Utility District (SMUD), Sacramento, California. Dr. Hofu Wu (Evaporative Cooling Institute) 714-869-0527, Bruce Vincent (SMUD) 916-732-5397. SMUD is continuing a demonstration and ground study of the potential for residential evaporative cooling in California.

Vari-Cool, Santa Rosa, California and Hastings, Nebraska. Dennis Dworshak, 402-463-9821

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Ammonia Vapor Compression

Carrier Corp. (United Technologies), Syracuse, New York. Jon Sanberg, 203-674-3132

Stal Refrigeration, Bensalem, Pennsylvania. 215-638-7330

Hydrocarbon Vapor Compression

Carlyle Compressors Co, (division of Carrier Corp.), Syracuse, New York. 315-432-6237

Lennox Industries, Carrollton, Texas. 214-416-7515

Ammonia Absorption

Energy Concepts Inc., Annapolis, Maryland / Argonne National Laboratory, University of Chicago, Michigan. Dave Baurac (Argonne) 708-252-5584, Donald Erickson (ECI) 410-266-6521

Jet Propulsion Lab. / Southern California Gas Co., Pasadena, California. Ed Becker (SoCal) 213-244-5345, Jack Jones (Jet Propulsion Lab) 818-354-4717

Robur Corp., Evansville, Indiana. Mike Hall, 812-424-1800

Water and Lithium Bromide Absorption

Carrier Corporation (division of United Technologies), Syracuse, New York. Jon Sanberg, 203-674-3132

Trane Corp., La Cross, Wisconsin. John Szymanski 608-787-4259, Jean Smithhart 608-787-3747

York International, York, Pennsylvania - San Antonio, Texas. Michael Ricci (Pennsylvania) 717-771-7890 or Mark Fallek 717-771-6349 / (Texas), 713-849-2122

Solar Powered Absorption Air Conditioning

California Energy Commission (CEC), Sacramento, California. Phil Misemer, 916-654-4552. The state funded CEC has been testing a solar energy powered absorption air conditioning system, using a lithium bromide absorption cooling unit.

Zeolite / Water Cooling

Zeopower Company, Natick, Massachusetts. Dr. Dimiter Tchenev, Patricia Trundy 508-655-4125

Stirling-Cycle Helium

Carrier Corporation (United Technologies), Syracuse, New York. Jon Sansber, 203-674-3132

General Pneumatics, Scottsdale, Phoenix, Arizona. Stephen Zylstra, 602-998-1856

Oakridge National Laboratory (Energy Division) / Martin Marietta, Oakridge, Tennessee. Dr. F.C. Chan, 615-574-0712

Sunpower, Athens, Ohio. William Beale, John Crawford, 614-594-2221

Desiccant Cooling

Albers Air Conditioning, Tempe, Arizona. Kevin Gee, 602-820-4280

Cargocaire, (Munters), Amesbury, Massachusetts. Hratch Adourian, 508-388-0600

ICC Technologies, Philadelphia, Pennsylvania. 215-625-0700

La Roche Chemical, Baton Rouge, Louisiana. Terry Parker, 504-356-8570
Munters, Selma, San Antonio Texas. Larry Klekar, 210-651-5018
New Thermal Technologies, Clearwater, Florida. Tom Hersey, 813-532-9921
Somerset Technologies, New Brunswick, New Jersey. Joe Pash, 908-356-6000

Thermo-Acoustic Cooling

Coolsound, Port St. Lucie, Florida. Frank Wighard, 407-337-5113
Los Alamos Laboratory, New Mexico. Mr. Greg Swift, 505-667-5061, 505-665-0640

Thermoelectric, Magnetic

Astronautics Corp., Madison, Wisconsin. Richard Foster, 608-221-9001
Thermotrex Corporation (division of Thermo Electron Technologies), Waltham, Massachusetts. Pat Clery, 617-622-1125

Passive Cooling Reducing the Need for Air Conditioning

National Renewable Energy Laboratory (NREL), Golden, Colorado. Dallas R. Martin, 303-231-1198. NREL has designed heat blocking window coatings that could open up a billion dollar market in the building industry. NREL is looking for industrial partners to further develop and license this technology.

Lawrence Berkeley Laboratory (LBL) / EPA, Berkeley, California. EPA Policy Planning and Evaluation (PM-221), 202-233-9190. Completed a research project examining the benefits of community tree planting and adding light colored surfaces to reduce heat.

REFRIGERATION

Ammonia Vapor Compression

Baltimore Air Coil, Jessup, Maryland. Robert Catef, 410-799-6262
Carrier Corp. (United Technologies), Syracuse, New York. Jon Sanberg, 203-674-3132
Engineered Refrigeration Systems, Mobile, Alabama. Mr. Steve Carroll, 205-471-2425
Evapcoi, Westminster, Maryland. Joe Szysmanksi, 410-756-2600
Fes, York, Pennsylvania. Jeff Granby, 717-767-6411
Frick (York), Waynesborough, Pennsylvania. Mr. Jack Bullitt 717-762-2121 and Mr. Mike Ricci 717-771-7890
General Refrigermetics Corp., East Elmhurst, New York. 800-582-0005
Imeco, Polo, Illinois. Chuck Spear, 815-946-2351
Niagara Systems, Buffalo, New York. Jack T. Rowland, 716-875-2000
Paul Mueller, Springfield, Missouri. Les Gardner, 417-831-3000
Safeway, Loring, Maryland. John Lopez, 301-918-6752, Safeway is an example of widespread use of ammonia based refrigeration in all warehouses and food storage areas, based on efficiency and lower cost than CFC/HCFC systems.
Stal Refrigeration, Bensalem, Pennsylvania. 215-638-7330
Turbo Refrigerating Co., Denton Texas. Diane Stevens, 817-387-4301
Vilter Mfg. Co., Milwaukee, Wisconsin. Jason Cole 414-744-0111
Henry Vogt Machone Co., Louisville, Kentucky. Ron Scherzinger, 502-634-1500

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Hydrocarbon Vapor Compression	Carlysle Compressors Co, (division of Carrier Corp.), Syracuse, New York. 315-432-6237 DKK Scharfenstein / Greenpeace (Germany), c/o Greenpeace, Washington DC. Damian Durrant, 202-319-2518. Manufactures Greenfreeze refrigerator using a propane and butane mixture.
Ammonia Absorption	Dometic Corp., Le Grange, Indiana. 219-463-2191, 219-463-4858
Zeolite / Water Cooling	Zeopower Company, Natick, Massachusetts. Dr. Dimiter Tchemev, Patricia Trundy 508-655-4125
Stirling-Cycle Helium	Oakridge National Laboratory (Energy Division) / Martin Marietta, Oakridge, Tennessee. Dr. F.C. Chan, 615-574-0712 Stirling Technology Company, Richland, Washington. Brad Ross, 509-375-4000 Stirling Thermal Motors, Ann Arbor, Michigan. Christine Lewis, 313-995-1755 Sunpower, Athens, Ohio. William Beale, John Crawford, 614-594-2221
Evaporative Cooling	Fry Equipment Co Inc, Denver, Colorado. Louis N. Grounds, 303-922-8442
Thermo-Acoustic Cooling	Modine Corporation, Racine, Wisconsin. Jim Fireston, 414-636-1200 Naval Postgraduate School / Los Alamos, Monterey, California. Steve Garrett 408-646-2540, 408-646-2486, Paul Marto 408-624-6833, 408-646-2989, (Space Systems) 408-646-2772 Sonic Compressors Systems Inc, Glen Ellen, Virginia. Tim Lucas, 804-262-3700
Thermoelectric, Magnetic	Thermotrex Corporation (division of Thermo Electron Technologies), Waltham, Massachusetts. Pat Clery, 617-622-1125
Malone Cycle Refrigeration, Single Piston Compression Refrigeration	David Taylor Research Institute (DTRI), Annapolis, Maryland. Mr. Greg Swift (Los Alamos) 505-667-5061, 505-665-0640, Jim Hanrhihan (Annapolis) 410-357-3308 Sunpower, Athens, Ohio. William Beale, 614-594-2221
CO2 Refrigeration, Ice-Pond Process Cooling	Cryocon Containers Inc, Pacific Shipping Systems Inc Genencor International / New York State Energy R&D Authority, Rochester, New York. Kaj Hulk, 716-277-4300

Greenfreeze

The following companies manufacture Greenfreeze refrigerators which use hydrocarbons, an environmentally preferable substitute to CFCs. They are willing to enter into cooperation with refrigeration companies at all levels from distribution to sale of components to technology transfer, from pure technology transfer to conversion of existing facilities or delivery of new machines and relevant components.

FORON Hanegerite GmbH, August-Bebel-Str.24, 9366, Scharfenstein, Germany. Phone +49 3725 7206, fax +49 3725 7188.

Robert Bosch Hanegerite GmbH, Hochstr.17, Pf 856, 8000 Munchen 80, Germany. Phone +49 89 4808 -00, fax +49 89 4808 -2347.

Siemens-Electrogerite GmbH, Hochstr. 17, Pf 100250, 8000 Munchen 80, Germany. Phone +49 89 4808 -09, fax +49 89 4808 -2347.

Liebherr Hanegerite GmbH, Postfach 1161, 7955 Ochsenhansen I, Germany. Phone +49 7352 928-0, fax +49 7352 928 -408.

**Silica-Aerogel
and Gas-filled
Panel Insulation**

Whirlpool, Benton Harbor, Michigan. 616-923-5000, Chuck Bercher 616-923-5415, Mike Kauffman 616-923-5363. Whirlpool has developed flat panels using inert gases such as argon and krypton with low thermal conductivity, which are expected to be introduced to models of home appliances soon. As of January 1993, Whirlpool is one of the two finalists (with Frigidaire) in the California utilities super energy efficient refrigerator program and it is likely the design utilizes this technology.

Other Resources

For more information on these and other environmentally sensitive appliance manufacturers, please refer to the supplement to Climbing Out of the Ozone Hole called Sources of Safer Alternatives to Ozone Depleting Chemicals published by Greenpeace, Washington D.C., February, 1993, 202-462-1177.

LIGHTING

A Bright Idea - Energy-efficient lighting specialists. They do not deal with manufacturing, but rather they use charts and pre-set programs to assist customers in taking advantage of PG&E rebates for energy-efficient lighting. They offer free energy audits. The job is not difficult and does not require a degree, although a basic technical degree is helpful. Skills necessary include presentation skills and college-level communication ability. Contact: Mark at 415-969-7456.

Thin-Lite Corporation, 530 Constitution Avenue, Camarillo, CA 93012. Patricia Cramer, 805-987-5021. 45 employees. Manufacture of 12 volt DC fluorescent light fixtures and low voltage DC low pressure sodium light fixtures. Over 90 models available.

Osram-Sylvania - manufacturer of lighting products (energy-efficient and otherwise) including compact and fluorescent bulbs and ballasts. Contact: Mike Pitlick, regional sales representative, 408-980-8171 x233.

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Other Appliance Manufacturers, Servicers, or Associations

Those interested in contacting energy efficient appliances manufacturers to gauge their interest in locating at closing bases, should contact the following. He can send out a "business alert" to companies indicating the opportunity.

John Jiambalvo, Executive Director, Marketing Department
Association of Home Appliance Manufacturers
20 N. Wacker Dr., Suite 1500
Chicago, IL 60606
(312) 984-5800 phone
(312) 984-5823 fax

Air Conditioning Company, 6265 San Fernando Road, Glendale, CA 91201.
Ken Simon, 818-244-6571. Mechanical and air conditioning contracting, service, and maintenance.

Air Design Contractors - Heating and cooling contractor, sheet metal shop, HVAC design, energy compliance, and CAD/CAM plotting. Certified energy auditor. 7836 Fair Oaks Boulevard, Carmichael, CA 95608. Contact: Dennis Moffett, phone 916-944-2484, fax 916-944-3307. 19 employees.

California Energy Commission, Phil Misemer (916) 654-4552 and Ray Darby (916) 654-4676.

Pacific Gas & Utility, Dave Laybourne, (415) 972-5329.

Resource Management International, 3100 Zinfandel Drive, Suite 600, Sacramento, CA 95670. Larry Gawlik, 916-852-1300. Marketing of energy efficient products in lighting and heating systems.

Sacramento Municipal Utility District, Bruce Vincent, (916) 732-5397.

Southern California Edison, Joe Kelly, (818) 812-7682 and Chris Luker, 619-321-4244.

Interviews & Sources

Appliances: Efficiency and Use (brochure), California Energy Commission, Building and Appliance Efficiency Office, 916-654-4064

Association of Home Appliance Manufacturers, Information Center; contact Elaine, 20 North Wacker Drive, Chicago, IL 60606, 312-984-5800

A Bright Idea Company, energy-efficient lighting specialists; contact Mark, 415-969-7456

Climbing out of the Ozone Hole: Sources of Safer Alternatives to Ozone Depleting Chemicals, Greenpeace International, October 1992, 202-462-1177

Melanie Douchin, Greenpeace, 415-512-9025

Energy Source Directory, 1993 Edition, by Iris Communications, 503-484-9353

Robert Foster, researcher at **New Mexico State University**, Box 30001, Dept. 3 SOLAR, Las Cruces, NM 80003-0001, 505-646-4104

Brad Gustafson, **Pacific Gas & Electric Company Energy Center**, 851 Howard St., San Francisco, CA 415-973-7268 or 1-800-933-9555

Glenn Hourahan, **Research Manager, Air Conditioning and Refrigeration Institute**, 703-524-8800

The Most Energy-Efficient Appliances 1992-93, American Council for an Energy-Efficient Economy, 2140 Shattuck Avenue, Suite 202, Berkeley, California 94704

Types of Industry/Business

Residential weatherization
 Pre-fab home manufacture
 Energy consulting

Description of industry

Air leaks in ductwork and around plumbing, chimneys, vents, light switches, windows and doors can allow one to two housefuls of air to escape every hour. And without enough insulation, heat also transfers through the ceiling, walls, and floors of homes. In San Francisco Bay Area homes, the largest leaks are in heating duct connectors.

Stopping air infiltration can reduce heating and cooling bills by up to 40 percent. Loss of heat through infiltration accounts for 40 to 50 percent of a home's total space conditioning costs. Leaky ductwork in the attic or crawl spaces alone can account for 25 cents of every heating/cooling dollar spent.

Home weatherization eliminates leaks—both in the house and from the pocketbook. There are two methods of weatherizing homes: sealing and insulating. Sealing means reducing the amount of outside air that comes in through seams or cracks to infiltrate the living area inside a house. By creating a draft-resistant "thermal envelope," outside air can be prevented from coming in through gaps around ductwork, plumbing, vents, flues, doors and windows.³²

Insulating means lining a home's thermal envelope—floors, walls, ceilings, windows and ductwork—with materials that don't readily admit heat. Insulation effectiveness is measured by its R-value: the higher the R-value, the better the insulation. The minimum recommended R-value is R-30 for attics, R-11 for walls, R-19 for floors and R-6 for ductwork.

Pacific Gas & Electric (PG&E, the largest gas/electricity utility serving northern California) currently offers rebates as an incentive for residents to weatherize their homes, increasing demand for weatherization materials and services in the Bay Area. The program has also helped spur consumer awareness of the benefits of energy efficiency.

Conventional insulation comes in four basic varieties. *Fiberglass* and *rock wool* are either blown into place or installed as batts or rolls. *Cellulose* is either blown in or poured in, and *foam* typically comes in sheets but may also be blown into place.

Caulking, used in tandem with insulation, is basically a kind of pasty, tubed sealant used to seal cracks and holes in a house. While silicone

caulking can withstand the widest range of temperatures, many other types of caulking exist as well.

Alternatives to conventional insulation which use recycled materials and consider full life-cycle environmental impacts are available. These insulating materials are made from cellulose and mineral slag, as well as from a mix of recycled stone, paper and plastic. They are derived from resources that have already been partially processed, either in the manufacture of paper, plastic packaging or the creation of slag from the production of refined metals, primarily pig-iron, also copper and steel.³³

When further processed, these materials can provide excellent insulation, sound-proofing and/or fire-proofing. They also represent a processed resource that can reduce the need to extract, refine and manufacture virgin materials when fully utilized.

Most of these environmentally sensitive products have a Class A fire rating; i.e., they are fire resistant, and more resistant to high temperatures than fiberglass or cellulose. The fire-retardant treatments commonly used with cellulose insulation are borax, boric acid or ammonium sulfate. Cellulose insulation is non-toxic, safe to install and greatly effective in preventing heat exchange that could lead to a loss of R-value. Cellulose insulation also has a low amount of "embodied energy" (the amount of energy used in procuring the raw material and processing it into a useable product).

Mineral fiber insulation (also called mineral rock, or slag wool) is non-corrosive, exudes no odor and does not support the growth of fungus or bacteria. This insulation is made from waste slag and is non-combustible, with a melting point above 1200 degrees Celsius.³⁴

In addition to insulation, there are a variety of recycled materials and durable, low-cost technologies being applied to home construction. Some use waste resources such as straw or tires as building elements; others employ technologies such as honeycomb.

Market Potential

There are conflicting assessments of the market potential for weatherization services and products. Several factors indicate strong future demand. Some segments of the building industry and many utilities are strongly supportive of energy efficiency, and some industry experts believe all houses will eventually be weatherized. The Center for Resourceful Building Technology states:

Considering world population growth projections and diminishing resources, the use of [environmentally sensitive housing] technologies will most assuredly increase in the not-so-distant future.³⁵

Climatic factors (frequent wind, high summer temperatures in the East Bay and Central Valley) and the presence of many custom-built homes contribute to the need for residential weatherization in northern California. Also, the California Energy Commission (CEC) is promulgating regulations that may require builders to use energy consultants. The CEC has established two other regulations (Title 24, Part 6 and Title 20, Chapter 2) which mandate energy efficiency in buildings and appliances.

But energy ordinances are slow to take effect, and other prognoses are less optimistic about the industry, predicting little or no job creation potential in weatherization manufacturing in the Bay Area for the next two to four years. Finding new customers willing to upgrade their homes for energy efficiency without cash incentives from their utility company is difficult. This means that in the Bay Area, PG&E support for conservation measures is critical to the market potential of the residential weatherization industry. And according to one industry source, although PG&E has been a strong promoter of energy efficiency, this trend could be slowed or reversed due to a series of incentives which motivate the utility to focus on electricity conservation instead of gas conservation.³⁶

Other industry experts believe only a substantial increase in the price of oil and/or a strong environmental ethic will increase the job creation potential of weatherization materials installation. Currently, the market for weatherization installation isn't driven by private homeowners unless private market incentives are provided such as free installation, a rebate or a zero interest loan. With oil prices relatively low, the financial impact of energy costs on middle income residents is not sufficient to stir widespread demand for weatherization (although energy prices always have a big impact on low-income residents).

On a more encouraging note, regardless of the initial motivating force, once customers seek the services of energy conservation companies they often come back for additional energy conservation upgrades. According to one conservation company, 50 to 60 percent of its customers are repeat clients.

Weatherization materials are generally purchased by homeowners, energy consultants and cities with weatherization programs for low-income residents. Weatherization can be inexpensive—installing ceiling insulation, caulking, stripping and sealing cracks and gaps—or expensive, as in major home re-hauls.

Job Creation Potential

Manufacturing weatherization materials can generate a large number of jobs, depending on the size of the operation. Such fabric manufacturing plants can employ hundreds of workers 24 hours a day, seven days a week. All skill levels are required at these plants, from forklift operators to quality controllers and lab analysts. Few skills are required in the manufacturing of cellulose fiber. Tasks include: dumping truckloads of newspapers into a hopper which grinds them and adds fire retardant chemicals; mechanical bagging of the end product; and stacking of product prior to sale.

The challenges of creating jobs in this field are the same challenges confronting all manufacturers wishing to enter the state; cumbersome documentation requirements, high workers compensation insurance rates, stringent air quality and discharge regulations, and high taxes. In addition, most manufacturers of weatherization materials are well-entrenched in other regions, making them potentially difficult to attract.

Manufacture of prefabricated energy-efficient homes is a related industry with proven success in California. Better Building Systems, Inc. (Sacramento) designs and manufactures highly energy-efficient homes under the trademark Nature House. A company representative believes a centralized fabrication plant for a single region such as the San Francisco Bay Area is feasible and could create 20 to 50 jobs soon, increasing to 50 to 100 total over a ten-year period.

Both professional (architects, engineers, computer-aided designers, drafters, marketing professionals) and skilled labor jobs (robotics supervisors, packagers, machinery operators) are created by this business. Skills required for jobs in this industry include management, communication, computer drafting, machinery expertise (small power tools, pneumatic presses), sales and marketing and training. The proportion of jobs in a theoretical plant is:

10%	management
5%	communications
15%	computer drafting
25%	fabrication
10%	sales
15%	marketing
20%	training and field demonstration

Any growth in weatherization materials manufacturing will be accompanied by job creation in **installation**, another segment of the weatherization industry. Each county has a weatherization program, frequently run with federal funding. In addition to county programs, there are also private contractors who work in installation.

These jobs require a high school education, some training, limited carpentry/ construction and customer relations skills and a general building contracting license. Training is provided through public programs sponsored by utilities as part of PUC mandates. These training programs teach basic installation, advanced installation, inspection, assessment and energy specialization, and they provide certificates for various skill levels.

Worldwatch Institute estimates that if all low-income housing units in the U.S. were weatherized, a total 1.4 to 1.8 million job-years might be generated.³⁷ However, the market for federally-funded and utility-sponsored residential weatherization in San Francisco is reaching saturation, according to a representative of the San Francisco Economic Opportunity Council. Moreover, once all existing homes are weatherized, demand is likely to diminish, since new buildings will be built to comply with new energy standards and will not require retroactive weatherization.

The pay and advancement opportunities in installation work are not great. The jobs are not really career positions in that employees usually don't receive health care coverage, work can be seasonal depending on when utilities meet their quotas, and high pay and job security are not present.

CEC regulations have created a big job market for **energy consultants**. These people consult to engineers, builders and homeowners to help them comply with California's building codes for energy efficiency. Energy consultants are certified by the California Association of Building Energy Consultants (CABEC).

For energy consulting jobs, a technical background is beneficial although an engineering degree is not required. Consultants need to attend CABEC's seminars and conferences to study and keep current on codes which are updated every three to five years. Awareness of environmental concerns, a conceptual understanding of energy and technical aptitude (for extensive number crunching) are the primary skill sets.

Environmental, Health & Safety Issues

Sealing leaks and insulating homes reduces the amount of nitrous oxide and sulfur dioxide released into the environment (from power plant emissions released during electricity generation). It also reduces dependence on fossil fuels and the environmental problems (oil spills, acid rain, air pollution, etc.) associated with them.

While weatherizing homes is clearly beneficial to the environment in terms of saving energy, some insulations and caulking may contain hazardous chemicals. Indoor air pollution can be aggravated by tightly sealed buildings. Moreover, textile fiber manufacturing is a heavy industry. For these reasons, we advocate the use of only weatherization materials that are environmentally sensitive, such as those which use recycled, CFC-free and non-toxic materials.

Infrastructure requirements

Conventional **fabric manufacturing operations** (such as insulation and house wrap) require large facilities. Plants are often sophisticated and can be diversified into several product lines.³⁸ Currently, most of these plants are located in the southeast (North and South Carolina and Georgia). They employ large numbers of employees (500 or so) with multiple shifts.

A cellulose fiber manufacturing plant would require about 4,000 to 5,000 square feet. A prefabricated energy-efficient home plant would require the following estimated infrastructure:

Square footage requirements:

2,000-3,000	research, engineering, and design
20,000	manufacturing
10,000-15,000	distribution
2,000-3000	sales

In contrast to manufacturing operations, **installation** does not require much overhead. The only buildings needed are an office and a warehouse. Other requirements are vehicles and access to vendors.

Environmentally sound residential weatherization materials manufacture and installation are unlikely to create a large number of career jobs in the near future in the San Francisco Bay Area.

However, a growing need for new housing construction in the next two to four years (the result of population increases in central California and expectations of a revitalized economy) is likely to correspond with growth in the manufacture and use of resourceful building materials. Energy-efficiency laws and less availability of conventional residential

construction materials (timber from unsustainable logging of old-growth forests) will also contribute to greater usage of residential weatherization materials.

An alternative worth considering for a former military site is the creation of a retail "one-stop shop" for weatherization, including warehouse outlets selling environmentally sensitive materials, installation services and research and educational facilities. People would be drawn by the combination of technical expertise, product availability at warehouse prices, and educational information. Installation services in particular could create several labor positions such as construction, and a few supervisory jobs as well.

In San Francisco, this "center of expertise" arrangement would complement the efforts of Minor Home Repair (415-715-6990), a youth group in Hunters Point currently involved in training people to weatherize homes in the Bayview area.

With perseverance, creativity and careful planning, weatherization could potentially create some jobs, although not likely a significant number.

**Energy
Conservation/
Installation
Contractors
Companies,
Agencies and
Associated
Organizations**

American Synergy Corp - 2829 Whipple Rd., Union City, CA, 510-429-9610

Bay Valley Insulation - 44875 Industrial Dr. #I, Fremont, CA, 510-791-5535

Coast Insulation - 1086 N. 11th St., San Jose, CA 408-292-0432

Console - an energy consultant for PG&E in Stockton. They test windows to see if they meet California Energy Commission standards. Contact: Mike Hodgson, 209-474-8446.

Envirotherm Inc. - 156 Valparaiso, San Francisco, CA 415-982-0196

Pacific Energy Management - 325 Mowry Ave., Fremont, CA, 510-792-7932

Save Energy Company - This company makes homes and other building energy efficient through changes in lighting, the addition of insulated windows, and insulation of heating pipes. \$1.5 million in revenues. Contact: Michael Gorman, Save Energy Co., 2410 Harrison St., San Francisco, CA 94110, 415-824-6010

SDI Insulation Inc. - 151 Haskins Way #C, South San Francisco, CA, 800-870-1628

Synergy Environmental Inc - 2829 Whipple Rd., Union City, CA, 510-429-9600

Taylor Insulation - 1775 S. First St. #19, San Jose, CA, 408-295-1323

**Energy
Consultants**

William Abbay, Abbay Technical Services, 2111 First St., Eureka, CA 95501, 707-442-1433

Bill Abernathy, Energy Options, 1250 Walden Lane, Anaheim, CA 92807, 714-970-0132

Bill Adasiewicz, King Enterprises, P.O. Box 5617, Redwood City, CA 94062, 415-365-6488

Jeff Adolph, Pacific Energy, 680 W. Tenaya, Clovis, CA 92612, 209-297-3497

Shilajeet Banerjee, Cunningham & Associates, 512 Second St. 3rd Floor, San Francisco, CA 94107, 415-495-2220

Ronald Barr, Barr Engineering, 204 St Paul Drive, Alamo, CA 94507, 510-837-0928

Chris Baumann, Baumann Energy Calc Co, P.O. Box 2261, Fremont, CA 94536, 510-795-1545

Douglas Beaman, Douglas Beaman Associates, 612 - 13th St., Modesto, CA 95354, 209-524-1623

Lynn Benningfield, Valley Energy Consultants, 10308 Placer Lane Ste 100, Sacramento, CA 95827, 916-364-1786

*** For a complete list of energy consultants, please refer to the California Association of Building Energy Consultants, Membership Directory 1993, 916-921-2223 ***

The following is a list of manufacturers of building and weatherization materials that exemplify an efficient use of resources in their manufacture. These products are produced with an emphasis on environmental sustainability, including the use of recycled and environmentally-benign materials.

**Recycled Cotton
Insulation**

Cotton Unlimited - Manufacturer of Insulcot, a new form of cotton insulation which uses 80% to 85% recycled material and competes with fiberglass pink. They are working to get the product approved in California. Cotton Unlimited, Post, Texas, 79356, 806-495-3511.

**Recycled
Cellulose
Insulation**

All-Weather Insulation Co., Inc., Springfield, KY 40069, 606-336-3931

American Insulation, Inc., Bloomer, Wisconsin, 800-633-3179

CAN-CELL Industries, Inc., Edmonton, Alberta, Canada, 403-447-1255

Cell-Pak Inc., Decatur, Alabama, 205-350-3311

Cellin Manufacturing, Inc., Elkwood, Virginia, 800-825-5565

Central Fiber Corporation, Wellsville, Kansas, 800-654-6117

Champion Insulation, Lomira, Wisconsin, 414-269-4311

Clayville Insulation, Burley, Idaho, 208-678-9791

Energy Zone Manufacturing, Inc., Buffalo, Minnesota, 612-682-5755

Hamilton Manufacturing, Inc., Twin Falls, Idaho, 800-777-9689

IN-CIDE TECHNOLOGIES, Inc., Phoenix, Arizona, 800-777-4569

Insul-Mor Manufacturing, Ltd., Oregon, Illinois, 815-732-7973

International Cellulose, Houston, Texas, 713-433-6701

Louisiana-Pacific, Fenton, Missouri, 314-343-9103

Northern Insulation Products, Gibbon, Minnesota, 507-834-6519

Perma Flake Corporation, Greenville, Mississippi, 601-334-9852

Southern Cellulose, Atlanta, Georgia, 800-666-3590

Suncoast Insulation Manufacturing Co., Rochester, New York, 716-458-0330

THERMOGUARD Insulation Co., Billings, Montana, 406-252-1938. Spokane, Washington, 800-541-0579

Thermo-Pak Mfg., Inc., Fargo, North Dakota, 800-627-5190

CO2 and Water Blown Foams

Chrysler, Highland Park, Michigan. Mr. Tom Cavalesci, 313-576-8099

Dow Chemical, Midland, Michigan. 800-258-4636, 800-258-2436, 800-441-4369

Ford, Utica, Michigan. Mr. Spencer Teller, 313-826-0391, John Emmert, 313-322-9210

Vacuum Panel Insulation

Degussa Corp., Dublin, Ohio. Kenneth Cwick, 614-761-5484. Degussa is looking for U.S. customers and U.S. based production, to gain economies of scale in production. The advantages of vacuum panels include elimination of CFCs in foam, lower thickness and therefore greater appliance interior space, and greater energy efficiency. The panels are 3-5 times as effective insulators as CFC blown foams.

General Electric, Fairfield, Connecticut. David C. Warshaw, 203-873-8476

Massachusetts Institute of Technology, Boston, Mass. Mr. L.R. Glicksman, 617-253-1000

National Renewable Energy Laboratory (NREL), University of Colorado, Golden, Colorado. Tom Potter, D.K. Bensen, 303-231-1083, 303-231-1000

Owens-Corning, Granville, Ohio. Dr. Warren W. Wolf 614-587-7525, Gregg Bronk 419-248-8004

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Silica-Aerogel and Gas-filled Panel Insulation

California Institute for Energy Efficiency, Lawrence Berkeley Laboratory, Berkeley, California. Bruce Davies, 510-486-6457

Lawrence Berkeley Laboratory, Berkeley, California. Dr. Arlon Hunt 510-486-5370, Bruce Davies 510-486-6461

Lawrence Livermore Laboratory, San Francisco, California. Harry Dodson 510-422-1100, Mary Beth Acuff 510-423-4432

Other Insulation Products

American Sprayed Fibers, Merrillville, Indiana, 800-824-2997. Manufactures Dendamix spray-applied fireproofing made from a mixture of recycled paper, stone, and plastic. Sound-Pruf spray-applied acoustical insulation made from rock wool and cellulose and a liquid adhesive.

Bradford Enercon, Danville, Washington, 800-663-2758. Manufactures ENERWOOL mineral fiber insulation made from mineral slag - a byproduct from the production of steel, copper, or lead.

FIBREX Inc., Aurora, Illinois, 800-342-7391. Manufactures insulation blankets made from 92% recycled rock wool/mineral fiber from mineral slag.

International Permalite, Inc., Ontario, California, 800-933-3413. Manufactures a tapered roof insulation system consisting of fabricated 24"x48" Sealskin boards made from expanded perlite, binders from recycled cellulose, and water-proofing agents.

Entire House Systems

Better Building Systems, Inc., Sacramento, CA. Contact: David Wright, passive solar architect, 916-265-2794. Involved in designing and manufacturing highly energy-efficient homes, trademark Nature House. They are the first company in Northern California to use stress skin foam panels.

Mansion Industries, Inc., City of Industry, California, 800-423-6589. This company manufactures ENVIROCOR panels from waste agricultural fibers. Made from rye or wheat straw, or sugar-cane rind, these panels provide an economically sound method of avoiding the burning of these agricultural waste materials, while providing strong construction elements. Mansion Industries focuses primarily on low-cost housing for developing countries, and also provides technology for those interested in setting up manufacturing facilities.

Out on Bale, Tucson, Arizona, 602-624-1673. This company designs and supervises the construction of straw-bale houses. A low cost, low technology approach to home construction, this technology is well-suited for areas with limited resources, high seismic risk, severe climate, or where straw is considered a waste resource. Straw-bale construction has been experimented within the U.S. (especially in Nebraska) since the late 1800s.

Solar Survival Architecture, Michael Reynolds, 505-758-9870. Manufactures "Earthship" earth-sheltered, adobe finish houses using recycled tires, cans, and bottles as substrate for exterior and interior walls. The homes are designed with passive or active solar systems. These houses seem best-suited to southern regions... areas of low rainfall where adobe construction has been used for centuries.

Stone Container Corporation, Oak Brook, Illinois, 708-574-9551. Manufactures low cost "Basic" housing units made from corrugated fiberboard panels assembled with nuts and bolts. A cost-effective housing solution to inadequate housing caused by disasters, low economic conditions, or emergency relocations.

**Foundation
Systems &
Components**

Durox Building Units Limited, Great Britain, (STD Code 0375) 673344. Manufactures autoclaved aerated concrete blocks and reinforced headers.

FASWALL Concrete Systems, Augusta, Georgia, 404-793-8880. Manufactures exterior walls and foundations made from pine wood chips and cement.

Mearl Corporation, Roselle Park, New Jersey, 908-245-9500. Manufactures Mearlcrete Foam Liquid that can be used to make cellular concrete and foamed concrete. Can be used in residential construction to create lightweight concrete suitable for load-bearing walls, floors, roofs, and foundations.

North American Cellular Concrete, Chantilly, Virginia, 703-631-2700. This company is developing fly-ash autoclaved lightweight concrete; in research and development stages.

Sparfil International Inc., Concord, Ontario, 416-660-7758. Manufactures Sparfil Wall System that combines insulated Sparfil blocks and a surface bonding cement to form a fully finished wall that provides excellent energy efficiency with a slow thermal lag.

**Panel & Block
Systems for
Walls, Roofs,
and Floors**

Advanced Concrete Technologies Inc., Burlington, Massachusetts, 617-272-0588

AFM Corporation, Excelsior, MN, 800-255-0716

Atlas Industries, Ayer, Massachusetts, 800-343-1437 (Note: polyisocyanurate cores are formed with CFCs or HCFCs.)

BARRIER System, Canastota, New York, 315-697-7224

Bellcomb Technologies, Inc., Minneapolis, Minnesota, 612-521-2425

Concept 2000, Dittmer, Missouri, 314-944-5200

FASWALL Concrete Systems, Augusta, Georgia, 404-793-8880

J-DECK, Inc. Building Systems, Columbus, Ohio, 614-274-7755

NASCOR Incorporated, Calgary, Alberta, 403-279-1966. Langley, B.C. 604-888-4133. Markham, Ontario, 416-477-0391

Rastra Building Systems Inc., Riverside, California. 714-653-3346

Shelter Enterprises, Cohoes, New York, 518-237-4101

Sparfil International Inc., Concord, Ontario, 416-660-7758

**Additional
Resources**

For more information on these and other manufacturers of environmentally sensitive housing materials, please refer to the **Guide to Resource Efficient Building Elements** published by the Center for Resourceful Building Technology, P.O. Box 3413, Missoula, Montana 59806, 406-549-7678. The book is available at the PG&E Resource Center in San Francisco.

For information on certification to become an energy consultant, contact the **California Association of Building Energy Consultants (CABEC)** at 916-921-2223.

Building Education Center; workshops on building environment-friendly homes. 510-525-7610.

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Natural Building Network, coalition of building professionals and consumers on ecologically-safe housing. 707-823-2569.

The following is a partial listing of manufacturers of "conventional" weatherization materials. "Conventional" means these products do not necessarily contain recycled materials or by-products nor do they necessarily exemplify environmental sustainability in their manufacture. Some of the products may contain CFCs. However, they are effective at increasing the energy-efficiency of houses.

Insulation— Extruded Polystyrene Foam

Foamular Insulating Sheathing by UC Industries, Inc., 3 Century Drive, Parsippany, NJ 07054, 201-267-1605.

Amofoam & Amofoam-RCY by Amoco Foam Products Company, 400 Northridge Road, Suite 1000, Atlanta, GA 30350, 800-241-4402.

Styrofoam Brand Insulation by Dow Chemical, USA, 2040 W H Dow Center, Midland, MI 48674, 800-441-4369. (Dow's extruded polystyrene foam has not used CFCs since 1990.)

Insulation— Expanded Polystyrene Foam

Expanded Polystyrene (EPS) by BASF Wyandotte Corp, 100 Cherry Hill Road, Parsippany, NJ 07054, 800-526-1072.

Dylite Expandable Polystyrene by Arco Chemical Co., 3801 W. Chester Pike, New Town Square, PA 19073, 800-354-1500.

Insulation - Polyisocyanurate Foam

Barrier Board by NRG Barriers, 15 Lund Road, Saco, ME 04072, 800-343-1285.

Insulation

United Fibers - Makes cellulose insulation. Located in Benicia. Contact: Gary Kelbar, sales representative, 800-862-7599.

Housewrap

Tyvek made by E.I. du Pont de Nemours and Co., P.O. Box 80, 705, Wilmington, DE 19880-0705, 800-448-9835.

Typar made by Reemay, Inc., P.O. Box 511, Old Hickory, TN 37138, 800-321-6271.

Tuff Wrap made by Celotex Corporation, Building Products, One Metro Center, 4010 Boy Scout Blvd., Tampa, FL 33607, 813-873-1700.

ProWrap made by Abitibi-Price Corporation, P.O. Box 98, Roaring River, NC 28669, 800-334-3551.

Rufco-wrap made by Raven, P.O. Box 5107, Sioux Falls, SD 57117-5107, 800-635-3456.

Barricade made by Simplex Products Division, P.O. Box 10, Adrian, MI 49221-0010, 517-263-8881.

Amowrap made by Amoco Foam Products Company, 400 Northridge Road, Suite 1000, Atlanta, GA 30350, 800-241-4402.

Airtight Wrap made by Parsec, Inc., P.O. Box 551477, Dallas, TX 75355-1477, 800-527-3454.

Caulks and Sealants

DAP '230' Latex by DAP, Inc., P.O. Box 277, Dayton, OH 45401, 513-667-4461.

CS 2130 Polyurethane Sealant by Hilti Construction Chemicals, 5400 S. 122nd E. Ave., Tulsa, OK 74146, 800-879-8000.

Chem-Calk 915 by Bostick, Inc., 1740 County Line Rd., Huntingdon Valley, PA 19006, 800-726-7845.

Big Stretch by Sashco Sealants, Inc., 3900 E. 68th Ave., Commerce City, CO 80022, 800-767-5656.

Baysilone 400 by Miles Inc., Mobay Rd., Pittsburgh, PA 15205-9741, 412-777-2000.

B-100 by Adco Products, Inc., 4401 Page Avenue, Michigan Center, MI 49254, 800-248-4010.

Acoustical by Tremco, 3735 Green Road, Beachwood, OH 44122, 800-321-7906.

35 Year Acrylic Caulk with Silicone by Macklanburg-Duncan, P.O. Box 25188, Oklahoma City, OK 73125, 800-654-8454.

For more information on manufacturers of conventional insulations and caulking, please refer to the **Energy Source Directory - 1993 Edition** by Iris Communications. This guide to products used in energy-efficient housing is available in the PG&E Energy Resource Center in San Francisco.

Interviews & Sources

Dr. Charles Axten, North American Insulation Manufacturers Association, Alexandria, VA. 703-684-0084.

California Energy Commission Hotline, 916-654-5106

Brian Hong, San Francisco Economic Opportunity Council, 415-247-7835

Center for Resourceful Building Technology, Missoula, Montana, 406-549-7678

Guide to Resource Efficient Building Elements, compiled and written by Steve Loken, Walter Spurling, and Carol Price, Center for Resourceful Building Technology, 1991, 406-549-7678

David Wright, Better Building Systems, Inc., 916-265-2794

Pacific Gas & Electric Company, Smarter Energy Line, 800-933-9555

Fred Schwartz, Director of Super Energy Efficient Houses, Pacific Gas & Electric Company, 415-973-3705

Michael Gorman, Save Energy Company, San Francisco, 415-0824-6010

Raymond Oslowsky, Tyvek housewrap distributor, 800-952-8614

Pacific Gas & Electric Company, Energy Center, 851 Howard Street, San Francisco, CA 415-973-7268

Energy Source Directory, 1993 Edition, by Iris Communications, 503-484-9353

California Association of Building Energy Consultants, Membership Directory 1993, CABEC, 2150 River Plaza Drive, Suite 315, Sacramento, CA 95833-3880, 916-921-2223

Cool Energy, 1992, Michael Brower, published by The MIT Press

"Jobs Benefits of Expanding Investment in Solar Energy", pp 17-25, *Solar Industry Journal*, Fourth Quarter 1992, Volume 3, Issue 4, published by the Solar Energy Industries Association, 202-408-0660

¹ These gases are warming the earth more than it would otherwise be; according to the best climate models available, present trends will cause the earth to warm anywhere from 4.5 to 8.1 degrees Fahrenheit by the end of the next century. In comparison, today's global average temperature is only about nine degrees warmer than it was at the peak of the last Ice Age 18,000 years ago, when much of the Northern Hemisphere was covered by ice sheets kilometers thick.

² "Jobs in a Sustainable Economy," Renner, Michael, *Worldwatch* Paper 104, September 1991, p. 25.

³ And Skip Laitner, executive director of the Center for Global Change, University of Maryland.

⁴ The direct and indirect jobs generated by efficiency investments would account for 10 percent of the job gain. Savings from lower energy bills being spent in ways that create more jobs would account for about 90 percent of this gain.

⁵ Sanford Lewis, "Eight Principles of Genuine Partnership and Empowerment for Sustainable Industrial Development," report from the Good Neighbor Project for Sustainable Industries, Acton, MA, p. 11.

⁶ "Jobs Benefits of Expanding Investment in Solar Energy," *Solar Industry Journal*, Solar Energy Industries Association, 1992, p. 18.

⁷ A 1979 study for the Joint Economic Committee of the U.S. Congress made a detailed estimate of the 1990 employment benefits associated with a gradual "solar transition." It found that conservation and solar energy technologies would reduce consumption of nonrenewable fuels by 45 quads in 1990 (current annual U.S. energy use is about 80 quads), compared to "business as usual" projections. This required annual investment of \$66 billion (in 1978 dollars) in energy conservation and solar energy. That investment would stimulate creation of about 2.17 million jobs producing and installing conservation and solar devices, including components and raw materials.

Under that scenario, reduced consumption of nonrenewable fuels were predicted to save consumers and businesses about \$120 billion in 1990 (in 1978 dollars). About 1.14 million fewer jobs could be expected in the conventional energy industries, the industries that supply them, and the construction sectors that build their energy supply facilities. However, the dollar savings from the lower consumption of fossil and nuclear fuels would likely be spent on other goods and services in the economy, creating about 1.87 million jobs would be created. The study concluded that a solar transition could have supported a net employment gain of 2.9 million jobs by the year 1990.

⁸ H.S. Geller, J. DeCicco, and S. Laitner, *Energy Efficiency and Job Creation: the Employment and Income Benefits from Investing in Energy Conserving Technologies*, American Council for an energy-Efficient Economy, Washington, D.C., October 1992.

- ⁹ Another study, a 1979 analysis by the Council on Economic Priorities, looked at the employment impacts of various energy sources. It found that conservation and solar would create up to 1.4 times as much national employment per unit of energy supplied or saved, compared to a proposed nuclear power plant. In addition, 2.4 to 2.7 times more employment would be created nationally than would the equivalent use of oil, natural gas, and electricity.
- ¹⁰ In a typical solar water heating design, a black metal plate absorbs sunlight and transfers the heat to pipes (often high-temperature plastic) carrying water or, to prevent freezing in winter, a water-alcohol mixture. The absorber plate is topped by glass, and the rest of the system is surrounded by insulation. In water- and space-heating applications, heat from the solar collector is usually transferred to an insulated storage medium such as a water tank and distributed as needed.
- ¹¹ For example, the 10 MW Barstow plant is being revamped with a new generation of technology, and will likely be operative within a few years.
- ¹² In comparison, installed electrical-generation capacity in the U.S. is more than 650,000 MegaWatts, U.S. nuclear power production is about 400 MegaWatts a year, and about 354 MegaWatts of solar-thermal capability exists in Southern California.
- ¹³ One photovoltaics company interviewed indicated approximately 30 percent of jobs created by such a manufacturing facility are blue-collar jobs.
- ¹⁴ An important question is how much fossil energy input is required for solar systems compared to the fossil energy consumed by comparable conventional energy systems. Although this varies depending upon the technology and climate, the energy balance is generally favorable to solar systems in applications where they are cost-effective, and it is improving with each successive generation of technology. For example, a photovoltaic module must operate three to seven years in order for it to produce the energy used to create it, depending on how and where the module is used and how it was manufactured. This ratio is improving all the time.
- ¹⁵ An employee at a photovoltaics firm indicated that because solar manufacturers are seldom offered incentives or perks to attract them, an offer such as free floor space or another perk could be very effective at attracting them to a new location.
- ¹⁶ In addition, the state of California and Southern California Edison, a utility, are establishing a \$130 million research center on fuel cells in Riverside.
- ¹⁷ Fuel cells can operate as efficiently in periods of low electricity demand as at maximum production times. Rapid changes in power level are easily accommodated, allowing fuel to be used more efficiently than in conventional power plant technologies, which must produce at maximum power to maintain efficiency levels and then often have excess electricity on hand which is dissipated or wasted.
- ¹⁸ Japan has the largest fuel cell power plant in operation at this time, an 11 megawatt phosphoric acid power plant. Over twenty 200 kilowatt phosphoric acid fuel cell power plants are also in operation in Japan, as well as several other small demonstration units. Although the total of all units currently operating in Japan is probably less than 30 megawatts, this represents by far the largest level of operation by any country. Japan has expectations of over 1900 megawatts of installed fuel cell power by the year 2000. Italy will soon have the second largest operating fuel cell power plant in the world, at 1.2 megawatts, and a Canadian company is one of the leading developers of fuel cells for the transportation industry.
- ¹⁹ This is especially attractive to the gas utilities because they would essentially be taking the business away from the electric utilities. A building would not need electricity and gas supplied to it because the gas supply in combination with the fuel cell could alone produce the required electricity.

- ²⁰ Including furnace, heat pump, and room and central air conditioner use.
- ²¹ Including water heaters and the energy consumed to heat water for clothes washers and dishwashers.
- ²² Refrigerators, refrigerator/freezers, and freezers.
- ²¹ These are rated by their Energy Efficiency Ratio (EER), the ratio of the cooling output divided by the power consumption. The higher the EER, the more efficient the air conditioner. The most efficient room air conditioners have EERs ranging from 9.7 to 12.6, depending on cooling capacity.
- ²⁴ Indirect/direct evaporative cooling is a two-stage air conditioning method that cools primary air via a heat exchanger, while the secondary air carries away the heat energy from the primary as generated vapor.
- ²⁵ A recent national industrial contest sponsored by utilities and evaluated by environmental groups such as NRDC challenged manufacturers to develop a commercially-viable, energy-efficient refrigerator. The Whirlpool model which won this contest does utilize HCFCs. Another company, Green Freeze, produces an HCFC-free refrigerator, but it is less energy-efficient than the Whirlpool model.
- ²⁶ Although it works best in dry, hot climates.
- ²⁷ Under its Building Energy Efficiency Standards, the CEC promotes and rewards energy efficiency. It awards users for using evaporative cooling as an efficient air conditioner by providing discounts on energy bills. The CEC is also planning to release a long-term plan in early 1994 for commercializing the evaporative cooling technology, and utilities such as the Sacramento Utilities District, Pacific Gas & Electric and Cal Edison give rebates for using it.
- The Global Climate Change Commission (part of the EPA) and the Department of Energy are also expected to promote evaporative cooling technology. In addition, ASHRAE (the American Society of Heating, Refrigerating and Air Conditioning Engineers) is developing industry standards, and the Evaporative Cooling Institute will have a certification program which will make design engineers more comfortable using the technology.
- ²⁸ The appliance industry publishes Energy Use Tables which list the amount of energy used by major appliances, providing a clear market advantage for the best performers.
- ²⁹ If the true cost of fossil-fuel energy (including environmental and social costs) was impounded in the cost of energy, and the cost of energy was not kept artificially low through subsidies to nonrenewable energy sources, the payoff to switching to energy-efficient appliances would come much sooner.
- ³⁰ To get information on training programs for this type of work contact Frank Powell, Sheet Metal Air Conditioning Contractors National Association, 1-800-458-6524.
- ³¹ CFCs have been used for many decades as heat exchange agents in refrigeration, air conditioning, and heat pump applications. In 1990, 207,000 tons of CFCs were used in the air conditioning sector to cool buildings and automobiles; an additional 19,000 ton were used in refrigeration systems. The Montreal Protocol (an international treaty mandating the rapid phase-out of ozone-depleting chemicals), is inciting refrigerator manufacturers to research CFC-free substitutes which are reliable, efficient, and compatible with existing technologies.

HCFCs, while being touted as a short-term substitute, are also proven ozone-depleters and contribute to global warming. According to the 1990 Intergovernmental Panel on Climate Change, one kilogram of HCFC-22 lasts in the atmosphere an estimated 15 years and has 4,100 times the global warming potential of carbon dioxide over a 20-year time span. The EPA is mandating that the use of CFCs be phased out by the end of 1995 and HCFCs be phased out by 2020 in the U.S.

- ³² While very beneficial from an energy standpoint, this weather-proofing may have a negative impact on indoor air quality. Please see the Residential Pollution Prevention/Control section on air duct cleaning firms for more.
- ³³ Artificial logs, for comparison, burn at 200-260 degrees Celsius; a steel mill furnace operates at about 2100 degrees Celsius.
- ³⁴ Loken, Steve; Spurling, Walter; Price, Carol; Guide to Resource Efficient Building Elements, Center for Resourceful Building Technology, p. 63. 406-549-7678.
- ³⁵ Through its rebate programs for efficiency upgrades, PG&E has been a strong force promoting insulation. The utility is committed to a goal of fulfilling 70 percent of new demand in the 1990s through conservation. PG&E's incentive for promoting efficiency is created in part by a collaborative effort with the Natural Resources Defense Council which allows the utility to earn profits on conservation programs based on projections of energy saved. However, the Public Utilities Commission (PUC) is now requesting documentation of such energy savings, a difficult task since insulating homes primarily saves gas instead of electricity, and it is much more difficult to prove gas savings than electrical savings. With profits contingent on proof of energy savings, the utility may be motivated to concentrate more effort on electricity conservation where savings are more easily measured. The result could be a decreased emphasis from PG&E on residential gas conservation measures.
- ³⁶ "Jobs in a Sustainable Economy," Renner, Michael, Worldwatch Paper 104, September 1991, p. 26.
- ³⁷ For example, DuPont makes their house wrap, Tyvek, in a single, large, sophisticated plant in Richmond, Virginia. The plant is diversified into 29 different grades of materials, with their primary markets being envelopes, clothing, sporting wear and others. Tyvek is actually only a "third market"—a smaller or lower priority market—for this plant.

Recycling/Source Reduction

Section III

Introduction

Recycling offers an excellent means of diverting solid "waste" from landfills and conserving resources. Products made from virgin materials generally use far more energy and water than recycled products, and generate more toxic waste during production. Moreover, according to a variety of sources ranging from WorldWatch Institute to the Institute for Local Self-Reliance, recycling and composting create more jobs per ton than disposing of waste in landfills.¹

State law requires that cities and counties reduce the amount of waste landfilled by 50 percent (from 1989 levels) by the year 2000. Millions of dollars are expected to be invested in the businesses that will collect, process, remanufacture and resell recycled materials. Between 40,000 and 45,000 new jobs could be created in recycling industries over the next seven years, according to the California Integrated Waste Management Board. A 1991 Planning and Conservation League report found there were roughly 1,077 companies involved in the recycling of paper, aluminum, metal or car parts in California, with 14,000 employed.²

Recycled product manufacturers create a broad variety of jobs, from low-skill laborers to manufacturing executives. However, there are frequently obstacles to overcome in siting recycling remanufacturing facilities. To be feasible, these businesses must be located near reliable, high-volume sources of recycled materials. They must overcome public perceptions of recycling operations as noisy, dirty and significant contributors to air pollution and water effluent.

Moreover, there are cost, quality and availability obstacles to widespread use of recycled/recovered materials by businesses and consumers. Reluctance to "buy recycled" will probably be overcome only through a combination of consistent consumer and corporate commitment, and government policies supportive of recycling (i.e., tax incentives, procurement preferences, minimum postconsumer waste content legislation).

Nevertheless, closing northern California military bases may provide excellent locations for remanufacturing of recyclables, due to both their proximity to large urban areas and attendant volumes of recyclables, and the existence of very large consumer markets (environmentally aware businesses and residents) for reprocessed goods.

Because the range of products, services and companies with potential to contribute to a recycling economy is nearly limitless, this section offers a list of some innovative recycling and source reduction opportunities being considered or developed by California businesses and agencies. Some of these operations manufacture products with potential to reduce waste; others divert materials that would otherwise be landfilled and

reuse them, or create new products from them. Many may be fruitful job creation sources for closing military bases.

Packaging reuse facility. The largest portion of the packaging-related waste stream is corrugated cardboard boxes. There could be a niche for a business that collects boxes from waste haulers for resale to entities using large quantities of boxes, such as commercial movers/shippers, trade show exhibit companies/ convention facilities, etc. Used boxes can be valuable (from \$.30 to more than \$4.00 resale value for a quality shipping box). Jobs created could include sales/marketing (to locate suppliers and customers for high-quality boxes, and recyclers for lower quality boxes), sorting, reconditioning, bookkeeping and office management positions. According to David Kemp of the Oakland Recycling Association, such an operation would require \$150,000 to \$250,000 in startup capital.

Biopolymer packaging manufacturing. In the United States, as much as half of all paper production and nearly a quarter of all plastics sold go into packaging.³ Many market opportunities are open to companies that can improve on the materials/processes used in packaging, by using renewable versus nonrenewable resources, by incorporating waste minimization techniques into manufacturing processes, by designing for recyclability, etc.

There is a new generation of "natural plastics" or "biopolymers" that can be used for packaging coming to market. Cargill, a large grain shipper, is now promoting a next-generation plastic made from lactic acid fermentation sugar (extracted from corn and other renewable materials) that the company says is 100 percent biodegradable, but 100 percent insoluble in water.⁴ The molecules used in the new plastic are all compostable carbohydrates.

The market for biopolymers is substantial and growing. A December 1992 study calculated then-current sales of biopolymers at 50 million pounds and projected an increase to 250 million pounds by 1996 and 1.2 billion pounds by 2002.⁵ Cargill, for instance, is targeting the 1.4 billion pound market for "serviceware" manufactured annually.

Jobs created by the biopolymer packaging industry range from scientists, engineers, chemists and other professionals to sorters, truckers and administrative positions.

Further research is needed to determine the reusability, recyclability and compostability of biopolymers. For example, their water insolubility raises questions about:

Bay Area Ship Recycling Project: Turning Scrap Metal into Jobs

A proposal to dismantle and recycle parts from obsolete military ships could create environmentally beneficial blue collar jobs. The Bay Area Ship Recycling Complex, proposed jointly by the Arms Control Research Center and the San Francisco Redevelopment Agency, would dismantle mothballed ships at several closing bases (Hunters Point, Mare Island and Alameda Air Station) providing approximately 1,300 jobs for local labor and dislocated defense workers. One third to one half of jobs created in San Francisco would be filled by minority residents of the Bayview/Hunters Point neighborhood that borders on the shipyard.

The project has environmental as well as economic benefits. Current practice for Naval ship dismantling is to sell decommissioned vessels to shipyards in Asia, circumventing U.S. environmental safeguards that prohibit release of asbestos, hydrocarbons, heavy metals and other toxics into the environment during demolition.

Pending approval by several base conversion commissions, the Bay Area Ship Recycling Complex could be operative by the end of 1994.

- the chances of successfully composting them with other municipal organic waste;
- their biodegradability time; and
- potential impacts on compost quality.

More information is also needed on likely air and water emissions from, and infrastructure requirements of a biopolymer manufacturing plant before an appropriate recommendation on siting can be made.

Manufacturing of high-tech composting toilets. The California Organic Recycling Council is comprised of 80 compost and boiler fuel producers in the state. These companies represent a \$25 million annual revenue market segment, with member companies developing 700 new jobs in the last 2.5 years.⁶ Composting toilets are a growth business for this industry.

Recycling of used motor oil filters. Commercial Filter Recycling, Inc. of Union City, California collects, treats and resells used oil filters. At full capacity, the company expects to recycle 3,600 tons of used oil filters annually and employ ten.

Recycling of used asphalt pavement.. EcoPave, a Long Beach, California company, recycles used pavement using microwave energy and hot air flow. Hot mix asphalt is produced by this process, and sold to contractors and agencies which build and repair roads. The company collects/reuses approximately 200,000 tons of asphalt/year and employs approximately 15.

DKD Investments is a grading and paving company that is building a concrete and asphalt recycling plant in Castroville. Recycled asphalt is used as road base and structural fill. The company plans to collect nearly 250,000 tons of concrete annually and to create four jobs.

A former asphalt recycling plant exists at Hunters Point Naval Shipyard. There may be an opportunity to convert this facility to recycling activities, depending on community needs and environmental impacts.

Plastic bucket beneficiation facility. Plastic barrels (55 gallon food-grade or non-food-grade) could be collected, washed and sold for reuse. An adjunct business would be granulating and selling the drums to manufacturers for recycling. Companies engaged in this business include Oakland-based Ultimate Container Corporation (contact Mike Hought 510-533-0411).

Targeting San Francisco Recycling Processing and Remanufacturing Opportunities

A Market Development Task Force has been organized by state Senator Milton Marks' office to identify appropriate recycling industries for Hunters Point Naval Shipyard and other San Francisco locations.

The Task Force is performing preliminary research on the capital requirements, job creation potential and environmental aspects of light and heavy recycling industries that could use feedstock from San Francisco's waste stream.

The Task Force—which includes (among others) representatives from local recycling and waste hauling businesses, from the City's Environment Commission and from the City's Recycling Program—plans to establish a roundtable to expand involvement in the planning process to more industry representatives, environmentalists, community activists and city agencies.

Other plastic recycling. A recent study projected that 2.8 billion pounds of plastic resins will be recycled into products by the year 2000, up from 500 million pounds in 1990.⁷ Crusader Plastics, located within the Ventura Recycling Market Development Zone, collects HDPE (high density polyethylene) and LDPE (low density polyethylene) and recycles them into the large industrial plastic cable reels used by telephone and cable companies. The primary sources of the recycled plastic are milk cartons and plastic soda containers. According to the company, no toxic byproducts or fumes are generated in the process.

The Plactory, a Santa Cruz business, uses postconsumer plastic to make plastic gift products, magnetic clips, contact lens cases, and display systems. The company plans to divert 100 tons of postconsumer plastics per year and create 10 to 15 new jobs by 1995.

Dropoff, secondhand goods and materials exchange centers. Urban Ore in Berkeley runs a for-profit center where residents may drop off reusable goods, appliances and scrap metals. The company also buys, sells and trades doors, windows, lumber, sinks, bathtubs, toilets, pipe, tile, glass and surplus building materials. Urban Ore also operates a general store with an inventory of used housewares, furniture, office equipment, jewelry, art, books, instruments, sporting goods and other items.

Composting facility. American Soil Products in Berkeley receives discarded organic materials and blends, mixes, ages or resells them as-is. Products include soil amendments, blended top soils and mulches for agricultural and landscaping uses. About 152,000 tons of compostable materials are generated in San Francisco every year, of which only about 6 percent is currently composted. This "waste" stream represents a significant opportunity for collectors, composters and marketers of finished soil amendment products.

Refurbishing/reuse of used building materials. Ohmega Salvage, also in Berkeley, buys and sells medium- to high-end building materials and house parts. The company performs hand demolition and refurbishing of many items. An affiliated company buys and sells high-end used and antique building materials and house parts, performing demolition and refurbishing by hand.

In San Francisco, Caldwell is a local building parts salvage company.

Textile recycling. At least one Bay Area company retrieves fabrics, textiles and clothes from large generators such as Goodwill Industries and recycles them into high-quality industrial rags, carpet backing, oil-

absorbent products and woven wipers.

Ready-to-assemble (RTA) recycled office furniture. The RTA furniture business in the U.S. is enjoying strong growth.⁷ A business that combines the cost, convenience and home delivery benefits of RTA furniture with the environmental marketing benefits of recycled products could serve the rapidly expanding northern California home office market. A central manufacturing facility could fabricate the furniture and distribute it via mail orders.

Furniture can be recycled using one of two primary methods. Wood can be run through a chipper and then remanufactured into boards through a gluing process (using non-toxic, degradable glues). Or discarded furniture can be refurbished and reused. Many times the final recycled furniture product is a hybrid of the two methods.

The demand for recycled office furniture continues to grow. Total sales for this market reached approximately \$350 million to \$400 million in 1992, up from \$250 million in 1991.⁹ The market is expected to continue to grow at a rate of 15 percent to 20 percent annually.

In addition to the manufacturing options listed above, recycling also involves the collection, sorting and processing of recyclable materials.

**Additional
recycling
opportunities**

Collection. While most of the *residential* collection and sorting of recyclables in San Francisco are done by Norcal at locations on 17th St. and Rhode Island and on Tunnel Avenue, there is significant other independent collection activity going on in the *commercial* sector. Moreover, significant new recycling business can be expected to be generated as new or just-emerging large commercial generators (such as the Port of San Francisco) are tapped.

Independent recyclers need areas for baling, sorting, storage, truck staging and office facilities. Locating such new facilities, or relocating existing facilities at former military bases may be appealing to recyclers.

Sorting and Processing. Recyclable materials diverted from the waste stream must generally be sorted to improve their market value. Often this is done by collectors, but there are opportunities for specialist companies to assume these tasks. Sorting creates jobs with few skill or training requirements; often it can be done by disabled or non-English speaking workers. Processing activities—such as cleaning or grinding recyclables, to bring them closer to the stage at which they can remanufactured into new products—can also generate jobs in a range of skill levels.

The opportunities for job creation through recycling at decommissioned military bases are great. Recycled product-based manufacturing in these urban areas makes sense, in part because it puts manufacturing near the source of raw materials. Traditional manufacturers that use virgin materials as feedstock (trees for paper, mineral deposits for iron, steel, etc.) must balance the costs of being located near forests or mines but far from the markets for their finished goods. In contrast, recycling manufacturers can "mine" raw materials from the same city to which they sell finished goods. Former military bases provide one of the last chances for siting large recycling areas in the middle of densely-built urban areas.

Companies, Agencies and Associated Organizations

A list of the largest Bay Area recycling firms, compiled by the San Francisco Business Times, is attached. Other companies include:

American Soil Products, P.O. Box 8238, Berkeley, CA 94707. Contact: Tom Russell, ph. 510-540-8011.

Arms Control Research Center, 833 Market Street, Suite 1107, San Francisco, CA 94103. Contact: Saul Bloom, 415) 495-1786.

Caldwell, 195 Bayshore Blvd., San Francisco, CA. ph. 415-550-6777.

California Integrated Waste Management Board, 8800 Cal Center Drive, Sacramento, CA 95826.

Callifornia Organic Recycling Council, contact: Dave Hardy, Bloomington, California.

Crusader Plastics, 134 North 13th Street, Santa Paula, CA 93060, ph. (805) 933-0004.

Ecology Center, Ecology Unit, 2530 San Pablo Avenue, Berkeley, CA 94702. Contact: Christopher Williams, ph. 510-548-2220.

Ohmega Salvage, 2407 San Pablo, Berkeley, CA 94702. ph. 510-843-7368.

Sauder Corporation, 502 Middle Street, Archibald, OH 43502. Contact: Kevin Sauder, 419-446-2711.

Urban Ore, Inc., Discard Management Center, 1231 Second Street Berkeley, CA 94710, (510) 559-4451.

Interviews & Sources

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Cal/EPA Report, Vol. 2/No. 10, p. 10. November 1993.

Cal/EPA Report, Vol. 3/No. 1, p. 7. January 1994.

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Industrial Marketing Management. Langrehr, Virginia B. and Frederick W. "Business Users' Attitudes Toward Recycled Materials," Nov. 1992, pgs. 361-367.

Loveland, David. Cargill Public Affairs Division. (202) 785-3060.

McCarthy-Bates, *Plastics World*, March 1993. "Biodegradables Blossom into field of Dreams for Packagers," pgs. 22-27.

Maria Moyer-Angus, Brown, Vence & Associates, 120 Montgomery Street, Suite 1000, San Francisco, CA 94104. (415) 434-0900.

Nation's Business, "All the Comforts of a Home Office", July 1993, pg. 26.

ODP. "Recycled Furniture Market Maturing" by Joseph M. Carbonara. September 1993. pgs 26-28.

ON BASE: *The Environmental Reporter of the Bay Area Military Base Conversion Project*, Arms Control Research Center, Volume 1, Issue 1, April 1994, p. 1-4.

Smith, Coy, Executive Director, Materials for the Future Foundation, 1230 Preservation Park, Oakland, CA 94612. 510-465-6333.

Stern, David. Site and Information Manager at Urban Ore, Inc.

Sustainable City, 1155 Ellis Street, San Francisco, CA 94109. Contact: Beryl Magilavy, 415-775-0396.

Urban Ore, Inc. "A Case Study of the Berkeley Serial MRF" Prepared by David Stern and Daniel Knapp.

¹ Only 67 landfilling jobs are created per million tons of solid waste, versus 467 composting and 600 recycling jobs.

² J. Shirley, *Jobs and the Environment*, report from the Planning & Conservation League Foundation, Sacramento, California, 1992.

³ "Jobs in a Sustainable Economy," Renner, Michael, *Worldwatch* Paper 104, September 1991, p. 16.

⁴ One drawback to first-generation starch-based plastics was a tendency to dissolve in moisture-ridden conditions (i.e. humidity, water penetration into packaging, moist storage containers, etc.), which discouraged industrial users.

⁵ "Degradable Plastics: Impact on Litter and Solid Waste Disposal." Business Communications Co. (Norwalk, CT)

⁶ "Jobs in California's Recovered Materials Economy," Regional Roundtable on Recycling & Community Economic Development Issue Paper 1, Materials for the Future Foundation, Oakland, CA.

⁷ Chemical Marketing Reporter. by Kemelior, Phillip *Rigid Plastic: The Long Haul* Jul 6, 1992 pg. SR12.

⁸ The RTA furniture market in the U.S. in 1992 was \$1.64 billion in manufacturers' dollars. The average annual growth rate over the 1987-1991 period of 9.3 percent was significantly above the annual growth rate of the Consumer Price Index (CPI) which gained an average of 4.5 percent. The largest RTA furniture manufacturer in the nation—25 percent market share—is Sauder Corporation, with revenues of \$325 million, and products ranging in price from \$150 to \$200.

⁹ Radley Resources, a Westfield, NJ, market research firm.

Largest Bay Area Recycling Companies

Published June 11, 1993

Ranked by average tonnage recycled per month			Average amount recycled per month (in tons)	Types of materials recycled	Types of clients					1992 Sales for Bay Area	Services			Minimum required for pick-up	Bay Area counties served: Alameda, Marin, Contra Costa, San Francisco, San Mateo	Number of full-time employees	Top Bay Area executive — Year founded
Rank	Firm name Address Phone/fax	Commercial			Industrial	Residential	Municipal	Hazardous	Collection		Drop off	Buy back					
1	Schnitzer Steel Foot of Adline Street, Oakland 94604 (510)444-3919/ (510)444-3370		25,000	Scrap metal	*	*	*	*	*	WND	*	*	*	Varies	All	70	Gary Schnitzer
2	Norcal Waste Systems ¹ 5 Thomas Mellon Circle, Suite 304, San Francisco 94134 (415)330-1000/ (415)330-1115		21,043	Aluminum, glass, plastic, paper, cardboard, news, metal, household hazardous	*	*	*	*	*	WND	*	*	*	No minimum	San Francisco, San Mateo	835	Michael Sangiacomo
3	SIMS-LMC Recyclers 800 So. Fourth St., Richmond 94804 (510)238-0808/ (510)233-7433		16,666 ²	Ferrous scrap, non-ferrous scrap, CA redemption (glass, plastic, cans)	*	*	*	*	*	WND	*	*	*	Varies	All	145	Robert Lewon
4	Harbor Sand & Gravel 775 Seaport Blvd., Redwood City 94063 (415)367-7124/ (415)369-6026		15,000	Concrete, asphalt	*	*	*	*	*	\$2 million				N/A	San Francisco, San Mateo, Santa Clara, Sacramento	10	Bill Montgomery
5	Weyerhaeuser Paper Co. 42305 Albraa St., Fremont 94538 (510)490-5887/ (510)490-5606		8,700	Paper, glass, aluminum	*	*	*	*	*	WND	*	*	*	Varies	All	125	Dave Ryniec
6	California CR Inc. 1942 Fairway Dr., San Leandro 94577 (510)357-0531/ (510)357-0520		7,000	Glass	*	*	*	*	*	WND				N/A	All	17	Miguel Diaz
7	Northern California Pulp & Paper Inc. 2085 Wayne Ave., San Leandro 94577 (510)483-3255/ (510)483-3852		4,200	Office and bindery paper, newspaper, magazines, cardboard	*	*	*	*	*	WND	*	*	*	500 Lbs.	All	25	Troy Bronstein
8	Marin Recycling & Resource Recovery 535 Jacoby St., San Rafael 94901 (415)453-1404/ (415)453-6665		4,000	Paper, cardboard, paint, aluminum, tin, glass, latex batteries, crank case oil	*	*	*	*	*	WND	*	*	*	No minimum	Marin	200	Joseph Garbarino
9	Bay City Recycling Services ³ 2615 Davis St., San Leandro 94577 (510)638-4327/ (510)632-7298		3,500	Cardboard, newspaper, glass, aluminum cans, computer printout paper	*	*	*	*	*	WND	*	*	*	Varies	Alameda, Contra Costa	65	Dave MacDonald
10	California Waste Solutions 1820 10th St., Oakland 94607 (510)832-8111/ (510)832-8206		3,000	Waste papers, glass, plastic, aluminum tin cans, wood products, PET plastic	*	*	*	*	*	\$1.6 million	*	*	*	1 Ton	All	19	David Duong
11	Paper Recovery of Northern California 25670 Nickel Place, Hayward 94545 (510)785-7311/ (510)785-7424		2,000	High-grade wastepaper including white ledger, colored ledger and mixed	*	*	*	*	*	WND	*	*	*	1,000 Lbs.	All	25	Michael Murray
12	Lakeside Non-Ferrous Metals 412 Madison St., Oakland 94607 (510)444-5466/ (510)444-1204		2,000	Non-ferrous metals, aluminum cans, certain alloys	*	*	*	*	*	23 million	*	*	*	1 Ton	All	23	Lester Finkel
13	L&K Debris Box Service Inc. 1313 Armstrong St., San Francisco 94124 (415)824-4322		1,500	Cardboard, wood, plastics, all types of paper, glass bottles, aluminum, steel	*	*	*	*	*	WND	*	*	*	1 Ton	Alameda, Contra Costa, San Francisco, San Mateo	42	Tony Lottice
14	All Star Recycling 998 Indiana Road, San Francisco 94101 (415)550-7500/ (415)821-7843		1,200	Printing waste, office waste, aluminum, glass	*	*	*	*	*	WND	*	*	*	2,000 Lbs.	All	20	John Gerber
15	Pacific Rim Recycling ⁴ 3690 Spring Drive, Benicia 94510 (707)748-6067/ (707)745-8273		1,200	Newspapers, cardboard, magazines	*	*	*	*	*	NA	*	*	*	Varies	Alameda, Contra Costa	NA	Steven Moore
16	The Sutta Co. 3211 Wood St., Oakland 94608 (510)652-8588/ (510)428-1063		1,000	Paper, glass, aluminum, books	*	*	*	*	*	2 million	*	*	*	500 lbs.	All	23	Avi Nesterman
17	Bay Polymer Corp. 44530 Grimmer Blvd., Fremont 94538 (510)490-1791/ (510)490-5814		750	Plastics	*	*	*	*	*	WND	*	*	*	10 tons	All	22	John LaFountain
18	Waste Resource Technologies ⁵ 895 Egbert Ave., San Francisco 94124 (415)822-2175/ (415)822-3852		700-800	Papers, metals, wood, cement, plastics, polystyrene, dirt	*	*	*	*	*	WND	*	*	*	Varies	Alameda, San Francisco, San Mateo	30+	Frank Cuetovael
19	Youth Enterprises Recycling 3641 Haven Ave., Menlo Park 94025 (415)364-3333		700	High-grade paper, glass, aluminum, 2-liter plastic bottles, color ledger paper	*	*	*	*	*	1.2 million	*	*	*	Varies	Alameda, San Francisco, San Mateo	6	Wamell Costa
20	Curbcycle ⁶ 22770 Main St., Hayward 94541 (510)537-9963/ (510)569-4242		676	Aluminum, glass, tin, plastic containers, polystyrene plastic, mixed waste paper	*	*	*	*	*	19,154	*	*	*	Weekly service	Alameda	7	Vern Rhodes Richard Valle
21	Ecology Center 760A Gilman St., Berkeley 94596 (510)526-1131/ (510)527-5309		500	Glass, tin, aluminum, newspaper, mixed paper, magazines, cardboard	*	*	*	*	*	150,000 ⁷	*	*	*	No minimum	Alameda	20	Peter Holzclaw director of recycling
22	Community Recycling Center 3550 Adeline St., Oakland 94608 (510)653-2104/ (510)652-9078		400	Aluminum, cans, glass bottles, plastics, cardboard, newspaper, office paper	*	*	*	*	*	200,000	*	*	*	100 Lbs.	Alameda, San Francisco	4	Salvador Soloranzo
23	Haight Ashbury Neighborhood Council Recycling (HANC Recycling) 780 Frederick St., San Francisco 94117 (415)753-0932		250	Glass, all paper graded by type, PET plastic, alum./steel cans, wine bottles for re-use	*	*	*	*	*	400,000	*	*	*	300 Lbs.	San Francisco	10	Kevin Drew
24	HMR (USA) Inc. 690 24th St., San Francisco 94107 (415)647-6071/ (415)647-2580		225	Computer breakage, office equipment, mainframes to PCs	*	*	*	*	*	WND	*	*	*	1 Ton	All	24	Michael Lowe
25	San Francisco Community Recyclers 639 Frederick St., San Francisco 94117 (415)731-8720		200	Glass, PET plastic, alum. cans and foil, steel cans, paper graded by type	*	*	*	*	*	720,000	*	*	*	N/A	San Francisco	10	N/A

This list includes recycling companies servicing the five counties of Alameda, Contra Costa, Marin, San Francisco and San Mateo. Aaron Metals Co., Oakland, recycler of scrap metals, declined to disclose tonnage. Browning-Ferris Ind. Inc., San Mateo, declined to participate. Includes subsidiaries: Bayshore Salvage, Golden Gate Recycling and West Coast Recycling.

¹Estimate obtained from Port of Redwood City annual report.

²Joint venture between Oakland Scavenger and Tri-Cad Community Recycling.

³Affiliated with Kart's Recycling of Oakland.

⁴Obe G.B. Debris.

⁵A division of Waste Management Inc.

⁶Represents material sales only. Does not include contract revenues.

Residential Pollution Control

Section IV

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Introduction

Smokestacks, clogged freeways and factory effluent seem appropriate icons to represent overconsumption of resources and environmental degradation. But even such mundane activities as cleaning the house or sending clothes to be dry cleaned have significant impact on environmental quality.

Environmental sustainability begins at home. As writer Paul Hawken puts it,

It is not good enough to simply clean up the mess; internalizing an ethic of preventing pollution before it happens is a prerequisite to achieving a sustainable economy.

This section reviews several companies that specialize in keeping indoor air free of harmful pollution and that manufacture non-polluting cleaning products. It also examines a new process that holds promise as an alternative to dry cleaning, and an approach to controlling sources of lead in the home. These consumer-oriented business opportunities are a chance to "eliminate the poisons, a chain of actions and consequences that energizes business, that stimulates innovation, that preserves employment and restores the environment."¹

Types of Industry/ Business

Clean dry cleaners

Introduction

There are 4,800 dry cleaners operating in California, more than 400 in San Francisco alone. Most use solvents and other chemicals which are serious contributors to air and groundwater pollution and a hazard to workers. Nearly all operate in highly-populated areas.

An environmentally safe alternative to chemical dry cleaning technology has existed since the 1940s, when a method using gentle detergents and steam instead of chemicals was invented by a German immigrant in London, Edward Friedburg. However, the chemical-dependent dry cleaning industry at the time was successful in stifling Friedburg's invention. His method is being reassessed as interest in eco-friendly dry cleaning heightens. Clean dry cleaning is a fledgling industry with tremendous potential for growth.

A Description of the Industry

The most omnipresent dry cleaning chemical is perchloroethylene, "perc" for short. It is used in lieu of water because it doesn't expand fabric fibers as much and therefore helps garments retain their shape as they dry. Perc causes dizziness and headaches in workers exposed to it, and

is a suspected reproductive toxin and carcinogen. Perc emits volatile organic compounds, a precursor to ground level ozone pollution, as it dries and contributes to ground water contamination as it is rinsed out of the garment.

One dry cleaner might emit a few pounds of perc into the environment each year. Individually, the problem is small but, when multiplied by the thousands of dry cleaners doing business in the Bay Area alone it is grave.

In 1992, the EPA and dry cleaning industry trade groups conducted a four-week study of a "wet" cleaning process called Ecoclean that uses biodegradable soaps, along with heat, steam and pressing, to clean garments. Former EPA Director William Reilly sent his clothes, along with 1,500 other garments belonging to federal employees, for use in the study.

The EPA concluded that, under certain situations, the Ecoclean wet cleaning process is technically feasible and economically competitive with chemical dry cleaning. At least in the short term, the EPA found no significant difference between the garment cleaning performance of wet cleaning compared to dry cleaning.

Market Potential

Nationwide, the dry cleaning industry earns \$5.3 billion in revenues each year.² Locally, San Francisco dry cleaners earn an estimated \$60 million in annual revenues.³ Since fewer than 20 percent of U.S. dry cleaners use a substance other than perc in the dry cleaning process, there is considerable potential for an environmentally safe garment cleaning business to achieve significant market share.

Moreover, new regulations may create favorable economies for companies that move away from chemical dry cleaning. Cal/EPA's Air Resources Board recently set new "closed-loop" machine and recycling standards to cut back emissions of perc by 75 percent. Such machines prevent perc from being emitted to the air when laundry loads are transferred from washer to dryer. The Bay Area Air Quality Management District has adopted local rules requiring dry cleaners to convert existing systems to closed-loop operation or to purchase new equipment. Cost estimates for conversion are \$7,000-\$10,000 while new systems cost \$20,000-\$40,000.⁴

This development means that in addition to a marketing advantage, a clean garment cleaner would almost certainly enjoy a pricing edge over competitors. Regulatory reporting requirements, disposal costs and supplies costs would be drastically lower than for companies using solvents and other toxic chemicals.

In addition, consumers may prefer wet cleaned to dry cleaned garments; the EPA study found customers thought wet cleaned clothes smelled better. Moreover, wet cleaning performed as well as dry cleaning in the categories of garment shrinkage, stretching and color change.⁵

The EPA's economic feasibility test results support the premise that wet cleaning is a financially viable business. A new facility dedicated exclusively to wet cleaning was slightly more profitable than a new facility dedicated exclusively to dry cleaning. Moreover, the return on an investment in a new wet cleaning facility was 26.3 percent compared to 14.7 percent for a new dry cleaning facility. Wet cleaning produces a better return because, although wet cleaning is more labor-intensive than dry cleaning and hence has higher labor costs, equipment costs are substantially less. Since a wet cleaning plant needs less capital, the return on investment is greater.

The EPA also studied mixed dry and wet cleaning facilities. The study indicated that a dry cleaning plant which added the wet cleaning process is less profitable than a facility dedicated exclusively to wet or dry cleaning because its costs are higher. New mixed mode facilities fared better; the return on investment was slightly greater than 100 percent dry cleaning facilities if at least 30 percent of the garments were dry cleaned. Below that threshold, costs increased because the dry cleaning equipment was underutilized.

The Ecoclean process is still experimental. The EPA study only tested garments over the span of a few weeks. The long-term performance of wet cleaning compared to dry cleaning has not yet been established. Later this year, the EPA will begin an 18-month demonstration project to test the long term effects of wet cleaning. Using a garment cleaning shop in Chicago for the experiment, the EPA will study, in addition to multiprocess wet cleaning, a mechanized wet cleaning machine and a microwave dryer.

A final and critical consideration is whether there will be sufficient residential populations near or within closing military bases to support clean dry cleaner operations.

Job Creation Potential

According to the EPA, multiprocess wet cleaning requires three times as much skilled labor as dry cleaning. At a dry cleaner, an employee might spend two hours per day removing spots from garments; a comparable employee using multiprocess wet cleaning would spend six hours on those duties. It follows that wet cleaners would employ more people than dry cleaners.

Most garment cleaners are small businesses employing fewer than ten persons. The key employees are the manager, a presser and a part-time counter person.

The manager (usually the owner of the business in a small operation) greets and waits on customers, supervises the garment cleaning process, tracks inventory and does the bookkeeping. The counter person assists the manager with his or her duties.

In the garment cleaning process, the manager typically does the cleaning and spotting (shirts and other garments are routed to independent plants for laundering). Once the garment is cleaned, the presser is responsible for finishing the garment.

As the clean dry cleaning business expands, it will likely take on larger accounts (e.g. uniforms and hotel laundry). These businesses can employ as many as 50 to 60 people in cleaning, spotting, pressing and finishing garments.

Related businesses are companies that retrofit existing dry cleaners with closed-loop equipment or recycle perc.

Environmental, Health & Safety Issues

Replacing perc with biodegradable detergents would reduce air and water pollution and improve public health. However, it is unknown whether the Ecoclean process could be a complete substitute for traditional dry cleaning until long-term tests are done.

Infrastructure requirements

A small, neighborhood garment cleaning shop would require 1500-2500 square feet. Generally, 75 percent of the space would be set aside for the work area, 10 percent for the customer service area, 5 percent for the manager's office and 10 percent for storage. A sample floor plan is reproduced in Figure IV-1.⁶

The basic equipment needed for a wet cleaning garment facility includes a mechanized wet cleaning machine, a power plant, an air compressor, an air vacuum, microwave dryer, all-purpose utility press, legger utility press, automatic pants topper, hand steam irons, iron stands, form finisher, spotting board, three-way puff iron, single-puff iron, clothes conveyor, commercial sewing machine and a blind stitch sewing machine.⁷

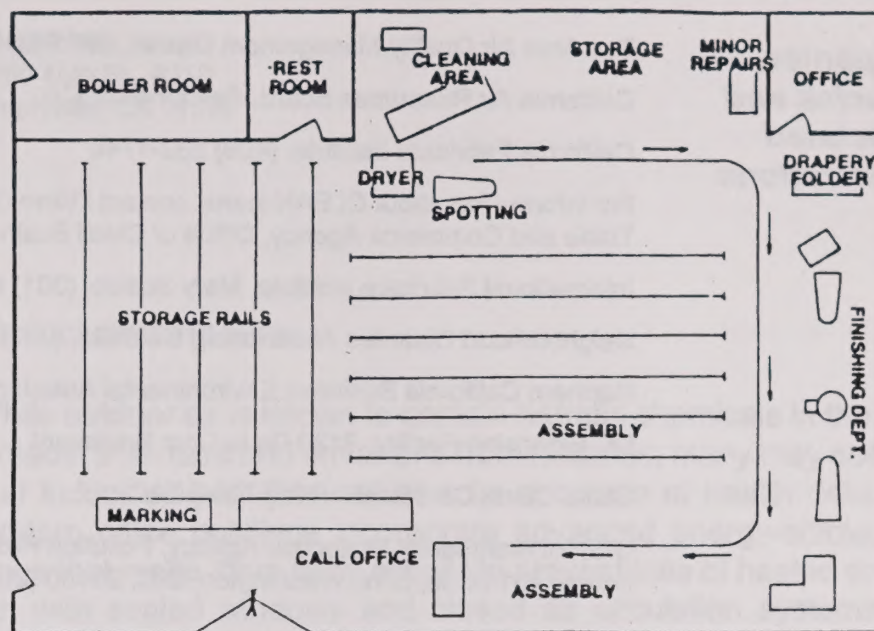


Figure IV-1: Sample Floor Plan

The supplies needed include spotters, spotting brushes, bone scraper, plastic bags, drapery bands, bagging jack/roll rack, strut hangers, metallic hangers, skirt clips, safety pins, drape hangers, drape tubes, sleeve formers, strip marking tags, staple guns and staples.⁸

The EPA feasibility study on wet cleaning found that the original investment required to get a wet cleaning shop up and running is 41 percent less than that for a dry cleaning operation. Financing for wet cleaning machinery may be available from California Loans for Environmental Assistance Now (CLEAN), sponsored by the California Trade and Commerce Agency, Office of Small Business. Any California small business is eligible for loans to purchase and install equipment, facilities or control technologies that will reduce or eliminate air pollution, hazardous waste or other environmental contaminants. The amount of the loan can range from \$10,000 to \$750,000. The loan carries a seven year term at a fixed, competitive interest rate. The agency has previously approved loans for the purchase of dry cleaning equipment.

The Northern California Business Environmental Assistance Center can assist small businesses in Northern California in complying with environmental regulations. The Northern California BEAC provides a comprehensive electronic information system containing information about environmental requirements, services and resources including environmental laws and regulations and environmental permits and permitting requirements. The Northern California BEAC is located at the University of California Extension Facility in Santa Clara.

Companies, Agencies and Associated Organizations

Bay Area Air Quality Management District, 939 Ellis St., San Francisco, CA 94109

California Air Resources Board, Sacramento, CA

California Fabricare Institute, (408) 252-1746

For information about CLEAN loans, contact Diane Cummings at the California Trade and Commerce Agency, Office of Small Business (916) 324-9582

International Fabricare Institute, Mary Scalco, (301) 622-1900

Neighborhood Cleaners Association, Bill Seitz, (212) 967-3002

Northern California Business Environmental Assistance Center

UC Extension Facility, 3120 De la Cruz Boulevard

Santa Clara, CA 95054. (800) 799-BEAC

U.S. Environmental Protection Agency, Pollution Prevention Information Clearinghouse, 401 M St., S.W. Washington, D.C. 20460 (202) 260-1023

Interviews & Sources

Doris Easley, dry cleaning business consultant (916) 782-3719

"Dry Cleaner Pushes Non-Toxic Methods to Laundry Industry", Journal of Commerce and Commercial, Feb. 5, 1993, p. 7A

Ohad Jehassi, U.S. Environmental Protection Agency, Project Manager,
Design for the Environment Program
401 M St., S.W. Mail Code 7406
Washington, D.C. 20460 (202) 260-6911

Ryan, "Is Dry Cleaning All Wet?", WorldWatch, May-June 1993, p.7

Dan Toone, Special Markets Manager
Safety-Kleen Corp.
400 Market St.
Oakland, CA 94607 (510) 832-7942

U.S. Environmental Protection Agency
"Multiprocess Wet Cleaning: Cost and Performance Comparison of Conventional Dry Cleaning and An Alternative Process", EPA Report No. 744-R-93-004 (Sept. 1993)

U.S. Environmental Protection Agency
Pollution Prevention Information Clearinghouse
401 M St., S.W.
Washington, D.C. 20460

Solvent Recovery Systems Companies

Bayday Chemical
2096-B Walsh Ave.
Santa Clara, CA 95050

Romic Chemical Corp.
2081 Bay Rd.
E.Palo Alto, CA 94303

Safety-Kleen Corp.
400 Market St.
Oakland, CA 94607

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Techniclean, Inc.
1250 45th St., #310
Emeryville, CA 94608

Types of Industry/ Business

Air duct cleaning firms

Introduction

While outdoor air is known to contain harmful chemicals in the form of exhaust from cars and emissions from factories, many may not realize that indoor air pollution can also be a source of health risks. Most modern office buildings incorporate advanced energy-efficiency designs that make them fairly airtight to prevent loss of heated or cooled air, with sealed windows and closed air circulation systems. This phenomenon is spreading to homes, as builders trying to conserve energy install thicker insulation and windows which retain more heat.

But ironically, while such design is beneficial from the energy-efficiency and outdoor air pollution standpoints, it can be detrimental to indoor air quality. And indoor air pollution is a serious matter; a five-year study by the U.S. Environmental Protection Agency showed that levels of some pollutants may be two to as much as 100 times higher inside than outdoors.⁹

Most people spend as much as 90 percent of their time indoors. As the indoor environment becomes more artificial, the risk of illness from indoor air pollution has increased. Increasing concern about health risks from poor indoor air quality is being heard from homeowners, renters, building managers and corporate leaseholders. This very real health threat creates business opportunities for air duct cleaning services.

Description of industry

Indoor air pollution can be exacerbated by dirty air ducts. Cigarette smoke is drawn into ventilation ducts and transported throughout buildings. Accumulated dust, mold and animal dander within air ducts can become breeding grounds for bacteria and particulate matter which can cause reactions ranging from headaches and sore throat to deadly Legionnaire's disease.

Air duct cleaning technology is quite simple. Essentially, air ducts are cleaned with large vacuum cleaners. A brush or auger is attached to a hose and placed in the air duct. As the hose moves through the duct, accumulated dust and particulate matter is dislodged by the brush and sucked into the hose.

Market Potential

The air duct cleaning industry is highly competitive. Entry barriers are low, setting up a lively competition between independent entrepreneurs and larger franchise operations. Establishing market share is generally expensive, due to the cost of advertising. Consequently, survival may depend on the owner's savvy in getting referrals from insurance adjusters.

However, the market for air duct cleaning generally is substantial and on the rise nationwide. There are thousands of office buildings, large apartment buildings and private residences in the Bay Area and beyond that could have a need for air duct cleaning services.

Office building managers, landlords and business owners may have their buildings' air duct systems cleaned periodically to reduce liability for "sick building syndrome." Homeowners may purchase such services out of concern for family health.

In addition, demand for air duct cleaning services may be stimulated by the fear of government regulation. The Indoor Air Quality Act of 1993, sponsored by Senators Mitchell, Chafee and Lautenberg, passed the U.S. Senate on October 29, 1993. The act requires numerous indoor air quality research and risk management activities such as federal and private research; management practices guidance/training; assessment of and recommendations for ventilation standards; contaminant health advisories; national indoor air quality response plan; various demonstration projects; a state grant program and an indoor air quality clearinghouse. Two other bills relating to indoor air quality are pending in the House of Representatives.

Demand for air duct cleaning services may in turn stimulate demand for related services provided by the cleaning businesses. For example, bacteria and harmful chemicals can accumulate on carpets; steam cleaning is known to remove these contaminants. Other related services include drapery and furniture cleaning.

By marketing their services to insurance adjusters, air duct cleaning businesses could also work on buildings damaged by fire. Fire-damaged buildings require air duct cleaning (to remove soot and ash from the ventilation system), as well as carpet, drapery and furniture cleaning/restoration.

Job Creation Potential

To start a carpet and air duct cleaning business, the owner or franchisee would need between \$50,000 and \$100,000 in capital. Initial investments include office equipment, vans, air duct cleaning equipment, carpet cleaning equipment, cleaning products and supplies.

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Initially, such a business would employ two or three people but could grow to between 25 and 50 employees. Jobs would include operations manager, office manager and cleaning staff. The business owner must have skills in marketing, sales, bookkeeping and management. Cleaning staff must have the ability to drive a van, operate the equipment, use cleaning products and maintain or repair equipment.

Environmental, Health & Safety Issues

Reducing indoor air pollution helps to prevent illnesses ranging from asthma and allergies to multiple chemical sensitivity and Legionnaire's disease. However, it is not a panacea. As *Sierra* magazine reported in January 1993, homes and offices can help keep indoor air cleaner simply by growing certain species of houseplants which absorb pollutants.

Moreover, many products used as carpet, curtain and furniture cleansers contain solvents with volatile organic compounds (VOCs) or other toxic compounds. These chemicals can contribute to ground-level ozone pollution, and pose a threat to worker safety.¹⁰

Infrastructure requirements

A typical business in the industry requires an office and about 1,500-2,000 square feet in warehouse space, to be used for both storage and for cleaning work that cannot be performed on site.

Companies, Agencies and Associated Organizations

In the San Francisco Yellow Pages there are ten listings for air cleaning and purifying equipment, 11 listings for air conditioning system cleaning and 119 listings for carpet, rug and upholstery cleaners.

One prominent franchise company is Steamatic, Inc. based in Fort Worth, Texas. Steamatic positions itself as an environment-friendly company and in 1991 sponsored the American Lung Association's annual Clean Air Week. Steamatic has been actively recruiting franchisees in Northern California.

Air Cleaning and Purifying Equipment

A. Alioto & Associates Air Cleaning, 2123 Powell St., San Francisco, CA

AQC, Inc., 151 Haskins Way, So. San Francisco, CA

Air Cleaning Specialists, 180 El Camino Real, Millbrae, CA

Air Cleaning Systems Co., 32420 Central Ave., Union City, CA

Air Exchange, Inc., 1185 San Mateo Ave., San Bruno, CA

Air Conditioning System Cleaning

A United Air Conditioning Cleaning (415) 641-1614

AQC, Inc. (415) 875-7117

Al's Chimney Cleaning, Inc., 149 Topaz Way, San Francisco, CA

Atlas Air Conditioning, 440 8th St., San Francisco, CA

Empire Air Conditioning, 22 Chicago Way, San Francisco, CA

Hot & Cold Mechanical Services, 636 Bellevue Ave., Daly City, CA

USA Chimney and Air Conditioning Cleaning, Inc., 149 Topaz Way, San Francisco, CA

Air Duct Cleaning & Servicing

Indoor Air Solutions Inc., 310 Shaw Rd., Unit D, So. San Francisco, CA, (800) 746-3667

Roboclean, 832 Folsom St. #740, San Francisco, CA, (415) 777-9494

Carpet/Air Duct Cleaning Franchises

Americlean, 6602 S. Frontage Rd., Billings, MT 59101, (800) 827-9111

Chem-Dry Carpet Cleaning, 3330 Cameron Park Dr., Cameron Park, CA

Coit Carpet Cleaners, 897 Hinckley Rd., Burlingame, CA

Duraclean International, 3954A Duraclean Building, Deerfield, IL 60015, (800) TO-CLEAN

Fabri-Zone International, Inc., 375 Bering Ave., Toronto, Ontario, Canada M823B1

Jani-King, Inc., 4950 Keller Springs, Suite 190, Dallas, TX 75248, (214) 991-0900

Modernistic Carpet Cleaning. 1271 Rankin, Troy, MI 48083 Rug Doctor Pro, 2788 N. Larkin Ave., Fresno, CA 93727, (800) 678-7844

Servicemaster Residential & Commercial Cleaning Corp., 855 Ridge Lake Blvd., Memphis, TN 38119, (800) 752-6688

Steamatic, Inc., 1320 University Dr., Suite 400, Ft. Worth, TX 76107, (800) 527-1295

Interviews & Sources

John Gellatly, Director of Development, Steamatic, Inc., 1320 S. University Dr., Suite 400, Ft. Worth, TX 76107, (800) 544-1303

Jeanna Haney, Environmental Protection Specialist, U.S. Environmental Protection Agency, 75 Hawthorne St., San Francisco, CA 94105-3901, (415) 744-1049

Types of Industry/ Business

"Green" cleaning services

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Description of industry

Products used in everyday cleaning chores—mopping, dishwashing, cleaning surfaces—contain chemicals that contribute to air and water pollution. A business providing environmentally safe house cleaning services may be a source of jobs at decommissioned military bases.

Generally, environmentally safe cleansers must be biodegradable, made from organic ingredients and phosphate-free. Many such non-toxic cleaners can be found in kitchen cabinets: baking soda; vinegar; lemon juice; laundry soap; vegetable oil; and borax. Products are also available from mail-order catalogs such as Real Goods and 7th Generation. Some Bay Area retailers, such as the Clean Team and Whole Earth Access, sell such cleaners.¹¹

Market Potential

Commercial businesses that require janitorial services and households seeking domestic help are potential markets for this business. The San Francisco Yellow Pages has 61 listings for house cleaning and approximately 200 listings for janitor services.

The cleaning industry in general is extremely competitive. However, given the high degree of environmental awareness in northern California, a truly non-toxic cleaning service could be expected to enjoy a significant marketing advantage over conventional companies.

However, given the high cost of advertising, establishing widespread name recognition would be a challenge. Moreover, consumers select house cleaning services based on price and degree of trust in the service. Environmental sensitivity would have to complement these factors.

The experience of The Clean Team is instructive. Jeff Campbell started a house cleaning service in 1979 as a career change. The company uses non-toxic products out of concern for the health of its customers and employees. In recent years, however, sales of cleaning products from its catalog and retail store has exceeded sales from house cleaning services.

Job Creation Potential

To start a house cleaning business, the owner or franchisee would need at least \$50,000 in capital, for the purchase of office equipment, a van or truck, cleaning equipment and supplies. The business would probably employ between ten and 25 persons. Jobs would include salespersons, cashiers, office manager, bookkeeper and cleaning staff. The business owner must have skills in marketing, sales, bookkeeping and management. Retail store workers must have skills in sales, customer

service, and operating cash registers or office equipment. Little education or training is required for cleaning staff.

Each closing base could probably support one such business. The market is too fragmented for a lot of companies in this field.

Environmental, Health & Safety Issues

The industry benefits the environment by increasing the market share of natural cleaning products and reducing the use of toxic chemicals.

Caution should be used in evaluating cleaning products. Chemical manufacturers are stretching the bounds of truth-in-advertising law as they seek to capitalize on the growing market for environmentally correct cleaning products. Claims that products are non-toxic, natural or biodegradable should be closely scrutinized.

Infrastructure requirements

If the business sells cleaning products as well as cleaning services, a relatively high-traffic/convenient storefront location suitable for retail sales is required. Approximately 2500 square feet of combined retail/display, office and inventory/cleaning equipment storage space is needed. It remains to be seen if some, all or any base redevelopment plans will include such high-traffic retail areas.

Companies, Agencies and Associated Organizations

Workenders is franchising businesses called "The Clean Team." Clean Team franchisees sell cleaning products advertised as non-toxic and biodegradable. The company also provides residential and commercial cleaning services. A Clean Team store is located at 2264 Market Street in San Francisco.

Bi-O-Kleen Industries in Portland, Oregon has developed cleaning products that claim to be cruelty- and preservative-free, nontoxic, noncorrosive and biodegradable. Bi-O-Kleen's products include all-purpose cleansers, phosphate-free dishwasher detergent, spot removers, laundry detergents, dish soaps and a glass cleaner. The company is also developing environmentally safe cleaning products for industrial and commercial use.

Bi-O-Kleen's sales are expected to top \$1 million in 1994, mostly from consumer products marketed through natural food retailers and environmental stores.

Fleabusters, a Ft. Lauderdale based company, is a flea control service that uses non-toxic products. It applies sodium polyborate to carpets in homes and businesses to kill fleas. A Fleabusters distributorship would need a van, equipment and supplies to run a flea control operation.

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Manufacturers of Green House- hold Cleaning Products

Allens Naturally, P.O. Box 339, Farmington, MI 48332-0339, (313) 453-5410

Co-op America, 49 The Meadows Park, Colchester, VT 05446, (802) 655-2975

Ecover Inc., 211 East Ocean Blvd., Suite 257, Long Beach, CA 90802. ph. 310-499-4925

Lion & Lamb Cruelty-Free Products, 29-28 41st Ave., Suite 813, Long Island City, NY 11101, (718) 361-5757

Mercantile Food Co., P.O. Box 1140, Georgetown, CT 06829, (203) 544-9891.
Distributor of Ecover products.

Mountain Fresh, P.O. Box 40516, Grand Junction, CO 81504, (303) 434-8491.
Manufacturer of Winter White detergent.

Murphy-Phoenix Co., P.O. Box 22930, Cleveland, OH 44122, (216) 831-0404.
Manufacturer of Murphy's Oil Soap.

7th Generation, Colchester, VT 05446-1672, (800) 456-1177

Shaklee, 444 Market St., San Francisco, CA 94111, (415) 954-2007

Interviews & Sources

Anderson, Ecologue, (Prentice Hall 1990)

Andrew Bruneau, Marketing Director, Bi-O-Kleen Industries, Portland, OR, (503) 774-1295

Jeff Campbell, The Clean Team, 2264 Market St., San Francisco, CA 94114, (415) 621-8444

"Cleaner, Faster, Greener?", Consumer Reports, February 1991, p. 105

Fleabusters, 2081 Behring Dr., Unit K, San Jose, CA, (800) 759-3532

Hutchings, "Green Gauge", New Statesman & Society, Dec. 4, 1992, p. 30

McPhee, "Breaking Away From Business As Usual", In Business, p.28

Siwolop, "Laboring in the 'Green' Laundry Lab", New York Times, Oct. 10, 1993, p. F9

"Soap Opera", The Economist, May 15, 1993, p. 86

Thayer, "Soaps & Detergents", Chemical & Engineering News, Jan. 25, 1993, p. 26

Types of Industry/ Business

Interim household lead reduction

Description of industry

Lead poisoning has been shown to cause a variety of severe illnesses among exposed children, ranging from hyperactivity to learning disabilities to brain damage. Full-scale lead abatement—complete removal of sources of lead such as paint and plumbing fixtures from buildings—can be prohibitively expensive. A new approach to preventing lead exposures is interim lead hazard reduction.

Such interim tasks include cleanings with special vacuums and household cleaners, minor repair work, fixing/replacing windows or doors. While not a complete solution to the problem of lead poisoning, there are many advantages to this approach:

- it can be accomplished at much lower cost than complete abatement;
- there is less disruption to families, since they do not have to vacate the home during the cleaning;
- employment entry barriers are lower; workers must be properly trained, but not highly skilled, in contrast to full lead abatement work.

Market Potential

Nationwide, an estimated 57 million homes and 900,000 public housing units contain lead-based paint. In San Francisco, about 260,000 housing units are believed to be contaminated with lead paint. Paint used in residences before 1978 may be lead-based; homes built before 1950 were definitely painted with paint containing lead, sometimes very high levels.

The Coalition to Prevent Lead Poisoning and the Mayor's Office on Housing have collaborated on a \$6 million grant from the U.S. Department of Housing and Urban Development (HUD) for lead hazard reduction. Some of the funds will be used to support lead abatement work in San Francisco low- and moderate-income private housing. Grant monies are expected to become available by the fall or winter of 1994.

Job Potential

The program envisioned by the Coalition would seek out youths who have never worked, other unemployeds and people connected with work programs. A pool of workers trained in basic interim lead controls would be created; these crews would perform the work quickly and inexpensively.

Lead control work can entail:

- Planting ground cover or grass as a barrier between lead in soil and children;
- Planting bushes near residences to block off exterior walls covered with lead-based paint;
- Covering any damaged paint surfaces, especially window sills and doors, with cloth tape;

- Fitting aluminum/plastic runners on windows so paint dust doesn't come off;
- Replacing windows and doors;
- Replacing faucets that contain lead;
- Using high-powered vacuum cleaners; and
- Mopping/cleaning with TSP cleansers.

**Environmental,
Health & Safety
Issues**

With training in proper cleaning and protection methods, any risk to worker safety from interim lead abatement can be kept to an insignificant level. The overall health benefits of lead abatement are improved health for children and clean, safe housing.

**Infrastructure
requirements**

These are approximately the same for "green" cleaning services (see preceding section).

**Companies,
Agencies and
Associated
Organizations**

See the Yellow Pages listings for Lead Removal & Abatement and Lead Testing & Consulting for companies active in the industry.

Coalition to Prevent Lead Poisoning, Consumer Action, 116 New Montgomery Street, Suite 233, San Francisco, CA 94105. Contact: Neil Gendel, 415-777-9648.

Mayor's Office on Housing

**Interviews &
Sources**

"Kids At Risk: Getting the Lead Out of Your Home," Sierra Club/Coalition to Prevent Lead Poisoning video, 1993. Contact: Neil Gendel, 415-777-9648.

Lead Poisoning Prevention Project newsletter, a publication of Consumer Action, Fall 1993.

¹ Paul Hawken, The Ecology of Commerce, p. 71 (HarperCollins 1993).

² International Fabricare Institute

³ There are more than 400 dry cleaners listed in the San Francisco Yellow Pages. According to the EPA report on multiprocess wet cleaning, a typical large dry cleaning establishment has an annual sales volume of \$260,000. Using that as a benchmark, we estimate that the average dry cleaner would earn \$150,000 in sales each year. Multiplying \$150,000 times 400 equals \$60,000,000.

⁴ Safety-Kleen Corp. recycles perc from dry cleaners. It takes perc-contaminated water, reclaims the perc, and sends it to Tennessee to be consumed by perc-eating bacteria at a wastewater treatment facility. According to Safety Kleen's 1992 Annual Report, it "picks up the waste materials on a regular basis from over half of the dry cleaners in the United States, and many in Canada. These wastes are processed in Safety-Kleen recycling plants."

⁵ Ryan, Megan, "Is Dry Cleaning All Wet?," World Watch, March/April 1994, p. 11.

- ⁶ Dry Cleaning Shop, AEA Business Manual No. X1037, p. 28 (American Entrepreneurs Association 1988).
- ⁷ *Id.* at p. 30-31, omitting equipment relating to dry cleaning.
- ⁸ *Id.* at p. 46-47.
- ⁹ Ryan, Megan, "Is Dry Cleaning All Wet?," *World Watch*, March/April 1994, p. 11.
- ¹⁰ "Healthy Homes: Keeping Pollutants at Bay," Tara Aronson, *San Francisco Chronicle*, January 12, 1994. P. 1 Section Z-3.
- ¹¹ Bi-O-Kleen Industries manufactures a non-toxic and biodegradable carpet cleaning product.
- ¹² In 1995, Belgium-based Ecover International BV will begin selling its Ecover line of biodegradable cleaning products in American grocery chain stores. A new factory is planned for the northwest region the same year.

Introduction

California's environmental technology industry is one of the fastest growing in the state, and is expected to continue to grow rapidly in the years ahead.

In 1991, the state's environmental technology industry generated \$1.1 billion in sales, up from \$800 million in 1990. The industry is expected to continue to grow rapidly in the years ahead.

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- 1. Environmental remediation and restoration services
- 2. Companies that produce instrumentation for environmental monitoring
- 3. Analytical laboratories that evaluate soil, air and water quality
- 4. Companies that assess human health risks resulting from environmental contamination
- 5. Companies providing waste prevention, handling and management services
- 6. Firms providing water use, pollution and water quality services
- 7. Firms that consult on environmental policy and management

Environmental Technology

Section V

Introduction

California's environmental technology industry is considered one of the engines which will propel the state's growth and exports in coming decades. According to *Environment* magazine,

In 1992, [U.S.] expenditures for environmental protection generated...\$14 billion in corporate profits; 4 million jobs [including 1.3 million in manufacturing]; and \$63 billion in federal, state, and local government tax revenues.¹

Total U.S. expenditures on environmental protection now average more than two percent of the gross national product annually.² California environmental technology firms command almost 25 percent of the market for environmental services/products. In 1992 in California, 7,000 environmental protection businesses generated an estimated \$20 billion in sales and employed 180,000. The state health department estimates that more than half of the environmental firms in the U.S. are located in the San Francisco Bay Area.

The benefits of environmental remediation and restoration are obvious; better human and eco-system health and public well-being. However, prevention of habitat destruction or toxic pollution is always more economical and environmentally beneficial than restoration after damage has occurred. Most cleanup and restoration efforts are extremely costly projects that take years or decades and fall short of returning natural resources to their original productivity levels.

Environmental technology encompasses a huge range of businesses including:

- Environmental remediation and restoration firms;
- Companies that produce instrumentation for environmental monitoring;
- Analytical laboratories that evaluate soil, air and groundwater samples;
- Companies that assess human health risks resulting from environmental contamination;
- Companies providing waste prevention, handling, treatment and management services;
- Firms providing water use, purification and reuse services; and
- Firms that consult on environmentally safe manufacturing.

The following discussion focuses on environmental engineering and consulting firms. The Alameda County Economic Development Advisory Board has already prepared a proposal for bringing environmental technology companies to the closing Alameda Naval Air Station. This document provides an excellent summary of the above technologies, and states the Board's strategy for making the base a hub of environmental research, development and commercialization.

Types of Industry/ Business

Environmental Cleanup

- Environmental engineering/consulting firms
- Pollution prevention plans

Description of industry

Environmental consulting and engineering firms provide services/products to rid air, soil and water of toxics and other contaminants. They also consult on pollution prevention and waste minimization.

Services provided by environmental firms are wide-ranging:

- identifying parameters and sources of environmental contamination;
- extracting and treating contaminated groundwater;
- developing and implementing landfill closure activities;
- measuring/reducing air emissions from manufacturing facilities;
- excavating and disposing of tainted soil;
- modeling underground geographic/hydrological features by computer;
- determining potential health and ecological implications of toxic contamination;
- advising businesses on regulatory compliance;
- providing expert witness testimony;
- managing solid and radioactive wastes;
- designing/constructing soil vapor recovery systems; and many others.

In the Bay Area, the largest 25 environmental consulting firms (15 of which have Bay Area corporate headquarters) generated \$507 million in local billings in 1992. They employ 14,076 full-time workers locally, including 2,261 engineers.³

Market Potential

The industry's strong growth from 1986 to 1990—between 8 and 10 percent annually, more than twice the growth in the general economy—has slowed as the industry has matured.⁴ However, international demand for environmental technology is projected to add \$7 billion more in gross revenues and 70,000 more jobs in California in the next three years,⁵ as environmental protection becomes a greater priority in developing and industrial countries.

The worldwide cleanup market is currently estimated at \$200-295 billion.⁶ One estimate projects this could peak at between \$500-600 billion by 2010.⁷ The cleanup of U.S. military facilities alone is one of the largest public works projects in history, with a potential pricetag in the hundreds of billions of dollars over the course of decades.⁸ (Remediation and monitoring of toxic sites can go on for as much as 30 to 50 years after cleanup equipment has been installed.)

Air pollution control and alternative energy sources (please see Alternative Energy section for more) are considered the biggest growth areas in environmental technology; pollution cleanup/control services are the largest segment of the domestic environmental technology market, worth an estimated \$139 billion.⁹ Continued strong growth in demand for remediation, consulting and waste minimization services is also forecast.

Private industry—especially utilities and chemical, petroleum, banking, legal and real estate firms—generates approximately 60 percent of total environmental services revenues, while 40 percent is government-generated. Mining, wood products, metals and electronics companies are considered growth areas.

Government initiatives to foster the environmental technology industry are legion, and contribute to the industry's strong potential for shuttered military bases:

**State and Local
Initiatives**

- The California Environmental Technology Partnership is a public/private consortium (state agencies, academics, national lab representatives, the environmental industry and public interest groups) which seeks to promote the growth, development and export of California's environmental technology industry. CETP's strategic plan for fostering the industry calls for: using California as a test bed for demonstrating the technologies; using closing military bases as test sites; expanding the state marketing and export assistance program to get greater market share abroad; streamlining regulations¹⁰ and providing tax incentives; and promoting partnerships with national research labs.

- The California Department of Toxic Substances Control has established a certification program for hazardous waste environmental technologies (hazardous waste management, site mitigation and waste minimization/pollution prevention). The certification process is intended to streamline the regulatory process¹¹ for getting such products to market and provide a competitive advantage for certified technologies.

National Initiatives

From Education to Employment In Environmental Cleanup Jobs

San Francisco State University City College of San Francisco are developing environmental curricula to train students in environmental technology jobs. CAREERPRO (California Economic Recovery and Environmental Restoration Project) is a partnership of private industry, government, educators, environmentalists, labor and neighborhood leaders, and focuses on employing dislocated defense workers and disadvantaged youth in environmental technologies.

City College of San Francisco offers a certification program with core courses in environmental technology. Several classes—including 40-hour HAZWOPER certification, required for environmental cleanup field work—are given at the College's Southeast Campus in South Bayshore. A similar certification program in lead abatement is being offered there.

- As part of President Clinton's National Export Strategy, the federal government (Department of Commerce) has initiated a partnership with businesses to help sell U.S. anti-pollution technologies abroad. The program includes proposals for streamlining regulatory barriers to development of the technologies, placing environmental specialists in U.S. embassies abroad to help promote American companies and establishing an inter-agency process to encourage export opportunities.
- The nonprofit U.S. Environmental Technology Export Council is a coalition of corporations, federal labs and trade associations that promote exports of American environmental goods/services.
- The U.S. Departments of Defense and Energy sponsor the development of innovative remedial technologies through Small Business Innovative Research programs. Small firms with science and/or engineering research capabilities can apply for assistance.
- Project Western Cleanup is a public-private partnership program sponsored by the Western Governors' Association to use federal facilities to prove new ways of doing cleanups.
- The International Industrial Environmental Alliance organizes environmental conferences and expositions with counterpart associations in Latin America and Asia, to facilitate environmental technology transfer from American companies.
- The U.S.-Asian Environmental Partnership, funded by the U.S. Agency for International Development, links U.S. technology companies with potential clients in Southeast Asia and China.

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

A Partnership for Environmental Technology Education (PETE) has been formed by the U.S. Department of Energy (DOE), the EPA and the Department of Defense (DOD). The program aims to link the technical resources of federal laboratories—such as Lawrence Livermore National Laboratory—and the private sector with community colleges.

The Environmental Careers Organization (ECO) has a \$6 million Diversity Initiative Program, a multi-year effort to expand the environmental profession to include people of color. ECO offers environmental career planning and job referral services, placing college students and recent graduates in short-term, professional-level positions in both the public and private sectors. Stipends in these jobs range from \$300 to \$700/week.

The City and County of San Francisco's Department of Public Works runs a successful apprenticeship program within its Bureau of Construction Management's Site Assessment and Remediation Division. Youths are brought on as interns, then become apprentices. Eventually, they can become engineers.

Job Potential

An important consideration for attracting environmental firms to converting military bases is heavy competition. Multiple California jurisdictions have initiatives to establish environmental technology hubs:

- Alameda County hopes to establish an incubator facility—ACET (Alameda Center for Environmental Technology)—focused on developing and commercializing innovative environmental technologies from existing Bay Area environmental companies. The facility would be sited at the closed Alameda Naval Air Station, and would generate 1,000 to 2,000 jobs over five years. Funding of \$43 million from the federal government has been requested. Another proposal being considered by the East Bay Conversion and Reinvestment Commission, Science City, asks for \$800 million in federal aid to build a center for high-tech manufacturing in 21st century industries;¹²
- Santa Clara has a joint venture program to attract environmental companies;
- The National Toxics Campaign has initiated a jobs and education campaign in Contra Costa County to try to develop environmentally sound jobs; and
- Chula Vista, Imperial Beach, National City and San Diego have created a partnership to establish a Border Environmental Commerce Zone to encourage environmental firms to locate there.

State legislation has created job opportunities in pollution prevention plan development. Pollution prevention plans identify changes in purchasing, storage, production and other processes that minimize toxic waste generation. State law requires generators of over 5000 kilograms per year of hazardous materials to develop plans to reduce this waste. Many smaller businesses are likely to engage in developing pollution prevention blueprints as well, to capitalize on resulting potential cost savings. Legislative deadlines for these plans are approaching.

Pollution prevention plans can be performed by technicians with a two-year degree (A.A.) or a certificate in environmental technology. Familiarity with computers, some chemistry training and familiarity with industrial source reduction methods are necessary. Much of this training can be gained through a 54-hour course in how to draft business pollution prevention plans.¹³

The number of jobs created by individual environmental consulting/engineering firms is variable. Satellite offices or smaller firms are run by

as few as five people, while the larger nationwide firms employ several hundred at a given site. The capital requirements for starting such firms can be minimal (standard office set-up for regulatory consulting) or substantial (equipment for engineering groundwater/soil treatment facilities).

The environmental technologies industry creates a broad range of professional and skilled labor jobs: regulatory compliance analysts; engineers (environmental, civil); scientists (wildlife biologists, soil scientists, ecologists, chemists, laboratory technicians, geologists, hydrologists); computer-modeling professionals; managerial, sales and marketing; mechanics and repair specialists; machine operators; government inspectors and regulators; delivery and heavy truck drivers; construction workers; landfill operators; equipment installers and cleaners; property appraisers; and laborers.

Blue collar cleanup jobs include inspecting monitoring wells, taking groundwater and soil samples, recording data, repairing equipment and driving trucks, in addition to a variety of standard construction tasks. A very limited number of low-skill government jobs (janitors, security officers) will be created once Bay Area military bases are closed and caretaker offices for remediation sites at the bases are established.

Political pressure is growing to obligate cleanup companies and government agencies involved in public remediation projects to hire more workers from the communities where toxic sites are located. All major municipal, state and federal cleanup projects require a percentage of work to be performed by minority-, woman- or disabled veteran-owned businesses. There is major growth potential for capable minority-run professional firms in the field.

Because competition for siting environmental technology companies is stiff in California, one fruitful approach may be to require firms that currently hold contracts on cleanup/investigation work at closing bases to open branches on location, and to require contractors participating in future bids to include opening on-site branches in their overall bid packages. Emergency response firms are another promising market segment that could be highly interested in office facilities that offer Bay or Delta access, providing quick response time for marine toxic spills.

Environmental, Health & Safety Issues

Workers employed in the environmental cleanup industry are required by federal law to undergo comprehensive safety training. These regulations also require use of protective gear, depending on the type of cleanup/toxics involved.

Instruments and equipment used in investigations, remediations and lab analysis is exposed to hazardous chemicals and must often be cleaned, sterilized or disposed of. Environmental labs analyze soil, air and water samples for minute concentrations of a broad range of toxic chemicals and materials (volatile organic compounds, heavy metals, hydrocarbons, solvents, chorides, pesticides, PCBs, asbestos and others).

However, some environmental consulting and engineering firms use equipment and lab subcontractors; contaminated equipment or samples are not always a part of such firms' day-to-day operations. And environmental firms must meet the same federal and state air and water quality standards required of industrial companies.

**Infrastructure
Requirement**

Environmental consulting/engineering firms are an excellent choice for all closing military facilities. Siting several medium-size or large firms at these locations could provide momentum for clustering other environmental technology companies. Such firms could also act as "anchor tenants," providing a critical mass of economic stimulus and making an area more attractive to smaller businesses.

Infrastructure requirements depend on the size of the firms. Generally, office space, access to mass transit and plenty of parking for trucks (and possibly storage space for cleanup equipment) are the most basic needs. Most closing bases could likely accommodate these needs.

**Companies,
Agencies and
Associated
Organizations**

A list of approximately 6,000 California businesses/satellite offices specializing in environmental technologies is available through:

Environmental Business International, 4452 Park Boulevard, Suite 306, San Diego, CA 92116. Contact: Grant Ferrier, President, 619-295-7685.

The California Environmental Technology Partnership is assembling a similar directory. Contact: Priscilla Galvez-Arango, External Affairs Office, Pollution Prevention and Technology Development, Department of Toxic Substances Control, P.O. Box 806, Sacramento, CA 95812-0806.

Lists of the largest Bay Area environmental firms and engineering companies (compiled by the San Francisco Business Times) are attached.

California Environmental Business Council, 4452 Park Boulevard, Suite 306, San Diego, CA 92116. Contact: Grant Ferrier, 619-295-7685. Trade association for environmental technology firms.

City College of San Francisco, 50 Phelan Ave., Box S-74, Office 312B, San Francisco, California 94112. Contact Pierre Thiery, Program Director, 415-239-3594 or Michael Malachowski, Ph.D., Instructor, 510-549-2520.

Largest Bay Area Environmental Firms

Published October 1, 1993

Ranked by 1992 Bay Area environmental billings										
Rank	Rank last year	Company name Address Phone/Fax	1992 Bay Area environmental billings	1991 Bay Area environmental billings	Number of full-time employees	Number of full-time, in-house Bay Area engineers	Sample of specialties	Sample of clients	Corporate head- quarters	Top Bay Area executive — Year founded
1	1	Montgomery Watson 355/365 Lennon Lane, Walnut Creek 94598 (510)933-2250/(510)945-1780	\$44.7 million	\$35.9 million	131	258	Environmental program mgt., industrial and haz- ardous waste, wastewater	Hewlett Packard, EBMUD, Prasidic at S.F.	Pasadena	Don Evenson 1945
2	1	CH2M Hill 1111 Broadway, Suite 1200, P.O. Box 12681, Oakland 94604-2681 (510)251-2426/(510)893-8205	42.1 million	46.2 million	150	230	Transportation, haz- ardous waste, solid waste, water/wastewater	City of S.F., Chevron, Caltrans	Denver, Colo.	William T. Dehn 1946
3	1	Davy Environmental 2440 Camino Ramon, San Ramon 94583 (510)866-1166/(510)866-6320	40 million	35 million	348	430	Remedial engineering, design and construction	Texas Water Comm., Army COE, Mobil Corp.	San Ramon	Peter C. Bond 1981
4	1	Harding Lawson Assoc. 7655 Redwood Blvd., Novato 94945 (510)892-0821/(415)892-0685	39.2 million	38.3 million	43	325	Investigation/remediation of contaminated sites; solid waste facility design	U.S. Army, IBM, Chevron Land and Development	Novato	Calude Corvino 1959
5	1	ICF Kaiser Engineers 1800 Harrison St., PO Box 23210, Oakland 94812 (510)419-6000/(510)419-6355	36 million	41 million	285	2,100	Environmental consulting services, remedial engi- neering, site investigation	Environmental Protection Agency, Dept. of Defense,	Fairfax, Va.	Raymond List 1914
6	1	Woodward-Clyde Consultants 500 12th St., Oakland 94607 (510)893-3600/(510)874-3268	34.5 million	39 million	80	247	Environmental/waste management, design and construction	EBMUD, Alameda County, PG&E	Denver, Colo.	Michael Richards 1950
7	1	Bechtel Corp. 50 Beale St., San Francisco 94106-1895 (415)768-3805/(415)768-4898	33.87 million	19.09 million	365	820	Remediation, pollution prevention/waste mini- mization, permitting	Chevron, Shell, Hewlett Packard	San Francisco	W. Roger Straw 1986
8	1	Brown & Caldwell 3480 Buskirk Ave., Pleasant Hill 94523 (510)937-9010/(510)937-9026	27.6 million	-1%	110	430	Environmental consulting and engineering, wastewater, solid waste		Pleasant Hill	Steve Fisher 1947
9	1	OHM Remediation Services Corp. 1990 No. California Blvd., Suite 400 Walnut Creek 94596 (510)256-6100/(510)256-6111	27.22 million	17 million	18	90	Numerous biological and chemical treatment pro- cesses, vapor extraction	Chevron, Hewlett Packard, Lockheed	Findlay, Ohio	Thomas Fluehr 1969
10	1	Dames & Moore 221 Main St., Suite 600, San Francisco 94105 (415)896-5858/(415)882-9261	18.6 million	6.91 million	106	140	Geotechnical engineer, environmental consulta- tion engineer/envmtl. serv.	PG&E, Chevron, Caltrans	Los Angeles	Willem C.B. Vilket 1938
11	1	Emcon 400 So. El Camino Real, #1200, San Mateo 94402 (415)375-1522/(415)375-0763	17.4 million ²³		45	990	Environmental consult- ing/engin., hazardous waste remediation	WND	San Mateo	James M. Folker 1971
12	1	Geomatrix Consultants Inc. 100 Pine St., San Francisco 94111 (415)434-9400/(415)434-1365	17.07 million	13.23 million	76 ²²	156	Soil and groundwater quality investigations/ remediation, air toxics	Southern Pacific General Electric, Port of Oakland	San Francisco	Mahmut Otus 1984
13	1	Levine Fricks Inc. 1900 Powell St., 12th Floor, Emeryville 94608 (510)852-4500/(510)852-2246	15 million	~15 million	48	60	Civil/geotechnical engin., hydrogeology, permitting, air quality management	PG&E, Catellus Development, Unocal Corp.	Emeryville	James D. Levine 1983
14	1	Resna Industries 505 Sansome St., San Francisco 94111 (415)291-9926/(415)291-9364	15 million	15 million	32	80	Environmental engineer- ing, consulting and construction	Unocal, Coca Cola, City of San Jose	San Francisco	Claude L. Ganz 1988
15	1	Black & Veatch 2300 Clayton Road, Suite 1200, Concord 94520 (510)246-8000/(510)674-0848	14 million	12 million	45	75	Waste, wastewater, residuals management, solid waste, stormwater	Modesto Irrigation Dist., cities of Livermore, Martinez	Kansas City, Mo.	Ronald G. Snedegar 1915
16	1	Kennedy/Jenks Consultants 303 Second St., 10th Floor, San Francisco 94107 (415)243-2150/(415)696-0999	12.5 million	13.9 million	87	350	Site assessments, haz- ardous waste remedia- tion, regulatory compliance	S.F. Intl. Airport, IBM, Santa Clara Co. Transit Agency	San Francisco	David D. Kennedy 1919
17	1	Tetra Tech 180 Howard St., Suite 250, San Francisco 94105 (415)874-1221/(415)874-5914	10.1 million	7.07 million	70	600	Site investigation/remedi- ation, litigation support, coastal studies	Dept. of Defense, Lockheed, PG&E	Pasadena	John E. King 1966
18	1	Canonie Environmental 7901 Stonenidge Dr., Suite 100, Pleasanton 94588 (510)463-9117/(510)463-2981	10.1 million	+25%	46	71	Hazardous waste design and construction, site assessments, RI/FS		Denver, Co.	Neno Duplancic 1979
19	1	Kleinfelder Inc. 2121 N. California Blvd., Suite 570 Walnut Creek 94596 (510)938-5610/(510)938-6419	9.7 million	3.8 million	14	104	Environmental/geotechni- cal engineering consulting	WND	Walnut Creek	Cyril M. "Bud" McRae 1961
20	1	EA Engineering, Science & Technology 3468 Mt. Diablo Blvd., Lafayette 94549 (510)283-7077/(510)283-8253	9 million	9 million	8	75	Geological studies/research, waste mgt., risk assessment	L.A. Dept. Power & Water, Tuol- omme Irrigation	Baltimore, Md.	J. Emil Morhardt 1973
21	1	ERM West Inc. 1777 Bolebo Drive, Ste. 260, Walnut Creek 94596 (510)946-0455	8.75 million	6.9 million	23	81	Site remediation, strategic environmental mgt., litigation support, air quality	Southern Pacific Transport, U.S. Navy, Catellus	Walnut Creek	Dr. Richard W. Stone 1984
22	1	Weiss Associates 5500 Sheldom St., Emeryville 94608 (510)450-6000/(510)547-5043	8.5 million	7.6 million	11	85	Environmental remedia- tion, risk assessment, legal support, site assess.	Department of Energy, Shell, Chevron	Emeryville	Richard Weiss 1980
23	1	Mark Group Inc. ²⁴ 3480 Buskirk Ave., Ste. 120, Pleasant Hill 94523 (510)946-1055/(510)946-9813	7.7 million	9.1 million	40	75	Environmental engineer- ing, compliance audits, air toxics	USS Posco, Tosco Refinery, Dow Chemical	Pleasant Hill	David Rogers N. D. Marachi 1964
24	1	URS Consultants Inc. California 100 California St., Ste. 500, San Francisco 94111 (415)774-2700/(415)398-1904	7.29 million	3.86 million	30	74	Risk assess., facility decommissioning, remedi- al design, air permitting	US EPA Regions IV and IX, US Army Corp. of Eng.	San Francisco	Martin Kottell 1957
25	1	ESI Engineering Services Inc. 1420 Willow Pass Road, Concord 94520 (510)603-0700/(510)607-0804	5.8 million	15.2 million	40	200	Regulatory compliance, pollution control engin./ constr., remedial action	Chemical Waste Management, La Posta, Canonie	Concord	Glenn I. Chase 1979

Largest Bay Area Engineering Firms

Published May 21, 1993

Ranked by total billings for Bay Area office(s) in 1992			Total 1992 billings for Bay Area office(s) ----- % Change from 1991	Number of engineers in Bay Area ----- Companywide	Full-time Bay Area staff ----- Companywide	Primary engineering services offered	Specialties								Top Bay Area executive ----- Year founded/Year founded locally ----- Headquarters
Rank	Rank last year ¹	Firm Address Phone/Fax					Commercial	Institutional	Industrial	Educational	Sports facility	Power plants	Transportation	Sewer/waste	Environmental
1	3	ICF Kaiser Engineers 1800 Harrison St., Oakland 94612 (510)419-6000/ (510)419-5355	\$129.96 million +21%	230 1,200	510 1,900	Environmental, infrastructure, industrial, construction and energy services	*	*	*	*	*	*	*	*	Ray List 1914/1921 Oakland
2	1	Bechtel Group Inc. 50 Beale St., San Francisco 94105 768-1234/ 768-9038	120 million -14%	1,351 9,525	3,357 20,792	Engineering, construction, techni- cal and management services; also petroleum, water resources	*	*		*	*	*	*	*	Riley Bechtel 1898/1898 San Francisco
3	9 ²	Montgomery Watson Americas Inc. 355 Lannon Lane, Walnut Creek 94598 (510)933-2250/ (510)845-1780	57 million +63%	189 720	277 2,120	Program management, water and wastewater treatment, water resources, industrial waste					*	*			Randall Raines 1945/1968 Pasadena
4	4	Morrison Knudsen Corp. ³ 180 Howard St., San Francisco 94105 442-7300/ 442-7432	56 million +8.5%	145 390	258 587	Engineering and construction mgt. for transportation and water resources projects				*	*				David Godney 1945/1945 San Francisco
5	2	The Failure Group Inc. 149 Commonwealth Dr., Menlo Park 94025 328-9400/ 328-8072	50.83 million -1%	146 218	310 425	Aeronautical, chemical, civil, elec- trical, environmental, marine, mate- rials and mechanical engineering									M. Gaulke, R. McCarthy 1967/1967 Menlo Park
6	5	CH2M Hill California Inc. 1111 Broadway, Suite 1200, Oakland 94604 (510)251-2426/ (510)893-8205	42 million -14%	162 2,716	235 4,011	Water, wastewater, hazardous and toxic waste, solid waste, energy, transportation systems			*			*	*	*	William Dehn 1948/1973 Englewood, Colo.
7	11	Harding Lawson Associates Inc. 7655 Redwood Blvd., Novato 94945 892-0821/ 892-0685	39.2 million +19%	50 190	350 980	Environmental, geotechnical, solid waste engineering, consulting	*	*	*	*	*	*	*	*	C. Conino, T. Williams 1959/1959 Novato
8	8	Woodward Clyde Consultants 500 12th St., Suite 100, Oakland 94607-4014 (510)893-3600/ (510)874-3268	39 million +2.6%	98 750	300 2,500	Geotechnical, environmental, waste management, design and construction services					*				M. Richards, G. Roussel 1950/1950 Denver, Colo.
9	6	Teknekron Communications Inc. 2121 Alston Way, Berkeley 94704 (510)849-3700/ (510)848-6851	34.1 million -24%	150 150	170 170	Telecommunications									Roger Strauch 1983/1983 Berkeley
10	13	Brown & Caldwell 3480 Buskirk Ave., Pleasant Hill 94523 (510)937-9010/ (510)937-9026	27.6 million +1%	110 430	320 950	Environmental consulting and engi- neering, hazardous materials, solid waste, air quality management						*	*		Steve Fisher 1947/1947 Pleasant Hill
11	15	Parsons Brinckerhoff Quade & Douglas Inc. 303 2nd St., San Francisco 94107 243-4600/ 243-9501	26 million +4%	98 1,500	175 3,300	Transportation planning, civil, structural, geotechnical, under- ground, water resources	*	*	*	*	*	*	*	*	John Belvedere 1885/1885 New York, N.Y.
12	18	Parsons De Leuw Inc. 120 Howard St., Suite 850, San Francisco 94105 495-6060/ 546-1602	25.92 million +5%	81 396	117 1151	Complete planning and engineer- ing services for transportation and infrastructure projects					*				Thomas Barron 1919/1948 Washington D.C.
13	7	Fluor Daniel Inc. 10 Twin Dolphin Dr., Redwood City 94065 595-6000/ 595-6009	25 million -37%	100 15,000	200 25,000	Feasibility studies, conceptual design, project mgt., engineering, construction, procurement	*	*	*	*	*	*	*	*	Victor Medina 1969/1969 Irvine
14	12	ABB Impell Corp. 5000 Executive Pkwy., San Ramon 94583 (510)275-4400/ (510)275-4521	24 million -15%	106 756	152 954	Engineering design and analysis services in civil, mechanical, elec- trical, I&C and plant operations		*	*	*	*	*	*	*	Joseph Famiglietti 1968/1968 San Ramon
15	31	Tudor Engineering Co. ⁴ 1800 Harrison St., Oakland 94612-3430 (510)419-8100/ (510)419-5355	20.52 million +71%	75 140	100 180	Consulting engineering services for transit facilities, highways, bridges, tunnels, dams, spillways					*	*			R. Janepaul, J. Williams 1950/1950 Oakland
16	14	Emcon 400 So. El Camino Real, #1200, San Mateo 94402 375-1522/ 375-0763	17.4 million ⁵ NA	45 194	170 990	Environmental, consulting and analytical laboratory services			*			*	*		James Folker 1971/1971 San Mateo
17	26	Geomatrix Consultants Inc. 100 Pine St., 10th Floor, San Francisco 434-9400/ 434-1365	17.07 million +29%	80 99	117 148	Geotechnical and foundation engineering, seismic engineering, ports and marine terminals, dams	*	*	*	*	*	*	*	*	Mahmut Otus 1984/1984 San Francisco
18	Not on list	Resna Industries Inc. 505 Sansome St., Suite 501, San Francisco 94111 291-9926/ 291-9364	17 million WND	14 28	127 237	Hazardous waste investigation, remediation, construction and operations, risk assessments					*				Claude Ganz 1989/1989 San Francisco
19	19	ESI Engineering Services Inc. 1420 Willow Pass Road, Concord 94520 (510)803-0700/ (510)803-0897	16.7 million +11%	60 80	250 270	Consulting, design, project and construction mgt., biotech pro- cessing, control systems	*	*	*	*	*	*	*	*	Glenn Chase 1979/1979 Concord
20	23	Levine Fricke Inc. 1900 Powell St., 12th Floor, Emeryville 94608 (510)652-4500/ (510)652-2246	15 million 0%	61 112	113 183	Civil/geotechnical engineering, hydrogeology, environmental ser- vices, permitting, air quality mgt.			*				*	*	James Levine 1983/1983 Emeryville
20	19	Sverdrup Corp. 1340 Treat Blvd., Suite 100, Walnut Creek 94596 (510)256-5200/ (510)946-0792	15 million +5%	59 1,988	140 5,103	Architectural design; civil struc- tural, mechanical and electrical engineering; construction mgt.	*	*	*	*	*	*	*	*	I. Grindheim 1928/1948 St. Louis, Mo.
22	21	Cygnus Group Inc. ⁴ 1800 Harrison St., 5th Floor, Oakland 94612 (510)419-4000/ (510)419-4180	14.4 million -7%	40 138	40 138	Consulting engineering (civil, structural, procurement, mechan- ical, electrical, fire protection)	*	*	*	*	*	*	*	*	Ray Forthey 1973/1973 Oakland
23	22	Black & Veatch 2300 Clayton Road, Suite 1200, Concord 94520 (510)246-8000/ (510)874-9458	14 million +17%	45 1,988	80 4,404	Civil/environmental engineering, construction mgt., hazardous waste mgt., industrial clean rooms	*	*	*	*	*	*	*	*	Ronald Snedegar 1915/1977 Kansas City, Mo.
24	35	Brian Kangas Foulk 540 Price Ave., Redwood City 94063 365-0412/ 365-1260	13 million +4%	31 31	146 146	Civil engineering, traffic and transportation, surveying, planning services	*	*	*	*	*	*	*	*	Stanley Kangas 1915/1915 Redwood City
25	25	Kennedy/Jenks 303 Second St., 10th Floor, San Francisco 94107 243-2150/ 896-09999	12.5 million -10%	56 147	133 318	Water supply, distribution and treatment, wastewater treatment, stormwater permitting, utilities	*	*	*	*	*	*	*	*	David Kennedy 1919/1919 San Francisco

The List includes engineering firms with offices in the five counties of Alameda, Contra Costa, Marin, San Francisco and San Mateo.

Information was gathered from company representatives.

Appendix 2 - Largest Bay Area Engineering Firms

V-7b

Footnotes:

¹Last year's List included 50 entries.

²Listed last year as James M. Montgomery Consulting Engineers Inc. In July, 1992, the firm merged with Watson Hawkins, an England-based engineering firm specializing in environmental engineering and pollution control technology.

³Transportation & Water Resources Group.

⁴Affiliates of ICF Kaiser Engineers, the No. 1 ranked firm.

⁵Includes Concord and San Jose offices; San Mateo office is corporate headquarters.

Researched by Barbara De Lollis

Commerce Business Daily lists pending Navy cleanup contract opportunities.

Defense Technical Information Center, 1-800-225-3842.

Environmental Careers Organization, 381 Bush Street, Suite 700, San Francisco, CA 94104-2807. Contact: Jack Chin, 415-362-5552.

Environmental Technology Advisory Council (advisory board to the California Environmental Technology Partnership). Contact: Office of Pollution Prevention and Technology Development, 916-322-2822.

International Industrial Environmental Partnership, 2707 Congress, Suite 1D, San Diego, CA 92110. Co-sponsoring a summer workshop and a fall conference and exposition on environmental technologies with the Federation of Thai Industries in Bangkok in 1994. Funded by the U.S.-Asia Environmental Partnership. Contact: Jack Flynn, Executive Director, 619-295-3461.

Partnership for Environmental Technology Education, P.O. Box 808, L-444, Livermore, CA 94551. Contact: Paul Dickinson, Lawrence Livermore National Laboratory, 510-422-6525.

Project Western Cleanup, Western Governors' Association. Public-private partnership to secure federal funding for demonstrating new treatment/remediation technologies at federal facilities in western states.

San Francisco Department of Public Works, Bureau of Construction Management, Site Assessment and Remediation Division, 3801 Third St. #600, San Francisco, CA 94124. Contact: Carole Ruwart, 415-695-7314

U.S. Department of Defense, Small Business Innovative Research, OSD/SADBU, The Pentagon Room 2A340, Washington, D.C. 20301-3061. Contact Mr. Bob Wrenn: 703-697-1481.

U.S. Department of Energy, Small Business Innovative Research, ER-16, Washington, D.C. 20585. Contact: Kay Etzler, 301-903-5707.

U.S.-Asian Environmental Partnership, 1133 20th St. NW, Suite 300, Washington, D.C. 20036. Contact: Al Short, 202-835-0333.

U.S. Environmental Technology Export Council, Contact: John Mizroch, Executive Director, 202-466-6933.

Interviews

Carl Anderson, Sierra Club Urban Growth Committee, 510-655-1895

Eila Arbuckle, Mayor's Office/Kent Sim's office, 415-749-2460, 415-749-2565

Paula Bruin, Environmental Protection Agency, Region 9, 15-744-1587

Dara Cox, California Office of Planning & Research, 916-322-3170

Grant Ferrier, Environmental Business International, 619-295-7685

Ray Jones, Urban Economic Development Corp., 923-0105

Michael Malachowski, Instructor, City College of San Francisco, 510-549-2520

Dwayne Marsh, San Francisco Foundation, 495-3100

Martha Matsuoka, Urban Habitat, 415-788-3666

John Mizroch, Executive Director, U.S. Environmental Technology Export Council,

202-466-6933.

Carole Ruwart, San Francisco Department of Public Works, Bureau of Construction Management, Site Assessment and Remediation Division, 415-695-7314

Susan Strong, Center for Economic Conversion, 415-968-8798

David Wong, California Department of Toxics Substances Control, 916-255-2113

Types of Industry/ Business

Environmental Restoration

- Civil engineering companies
- Biology/ecology firms
- Landscape architecture firms
- Land use planning firms
- Forest products companies

Description of industry

Restoration ecology is the attempt to return damaged habitats or ecosystems to the way they were before mining, logging, industrial accidents or development occurred. Environmental engineering firms, landscape architecture firms, civil engineering companies, land use planning companies and biology/ecology firms typically provide restoration services.

Restoration can never take the place of fundamental changes in the way humans manage resources and deal with natural processes. Manmade attempts to restore natural areas to their self-regulating wild state following disruptive activities such as logging, mining, landfilling and damming will always be imperfect, due to the complexity of natural systems. "The purpose of restoration is to repair previous damage, not to legitimize further destruction."¹⁴

Moreover, ecological restoration is most successful when it includes the long-term involvement of a concerned community willing to donate time and energy to the project. Also, restoration is usually very expensive, requiring public sector funding or public/private partnerships on many projects.

However, restoration projects can prevent worse damage to resources, jumpstart the natural recovery process or reverse a decline threatening the very existence of a resource. Restoration projects are generally desirable so long as conservation efforts also continue apace. Because

they usually require long-term maintenance (as much as five to ten years for forest restorations, for example), restoration projects are also a promising source of long-term jobs.

The nascent environmental restoration industry is centered in the San Francisco Bay Area. As the focus of the public, industry and policy leaders continues to shift from fixing environmental problems to preventing them, environmental restoration projects will become an important source of business and jobs for environmental technology firms.

Streams. Development, flood control, gravel mining, water projects or agriculture has wiped out as much as 95 percent of California's riparian habitat.¹⁵ Diminishing fish populations are attributable to stream and forest degradation. Silting from denuded, eroded forest lands clogs gills, smothers fish eggs and fills in spawning grounds. Flood controls such as channelization creates flows that wipe out overhanging vegetation and shelter for fish.

But an estimated 350 projects to restore or preserve California urban streams—including San Francisco's Islais Creek—have been under way,¹⁶ reflective of a national trend. These efforts bring creeks out of storm sewers or concrete channels and remake natural banks lined with native vegetation. As part of the San Francisco Bay Estuary Project, the U.S. EPA is creating an inventory of riparian/fish systems flowing into the Bay, and developing recommendations on aquatic diversity management. This preliminary work could stimulate policy changes or funding for stream restoration.

Stream restoration generally requires work on water flow, pollution controls and structural modifications. It can be very expensive; riparian restorations in California urban areas have cost from \$6,000 to \$100,000/acre, depending on land acquisition costs, the presence of endangered species and long-term maintenance costs.¹⁷ A California Department of Fish & Game report estimates the cost of restoring native fish populations in Central Valley rivers and streams at up to \$500 million. The largest restoration for solely environmental reasons is currently being conducted by the Army Corps of Engineers on the Kissimmee River, which feeds into the Florida Everglades. The project—estimated to cost between \$368 and \$422 million for construction and land acquisition—will take 15 years and reclaim 29,000 acres of filled or channelized land as wetlands. The state of Florida and the Army Corps are splitting the cost.

Forests. Clearcutting of trees has been shown to have devastating effects on both forest and stream ecosystems. The ability of wildlife to subsist in patchwork forests is inhibited. Removing trees near streams increases stream siltation (from erosion), water temperature (from increased sunlight) and algal growth. It also destabilizes stream beds and removes vegetation that is a food source for fish, greatly reducing fish spawning habitat.

Multiple successful forest restorations have been conducted on public lands, including restoration of old logging lands in Big Basin State Park by Sempervirens Fund, and a massive restoration of Redwood National Park.¹⁹ Such work is currently taking place at Castle Rock, Butano and Cowell state parks. One restoration expert who performs hardwood forest restoration on old mining lands in the eastern U.S. estimates the cost at \$5,000 to \$7,000 an acre.

Restoration of forests and wetlands generally involves land use planning, hillside stabilization, moving soil and rocks, identifying appropriate native plant/tree communities and planting such flora.

Wetlands. Approximately 90 percent of California wetlands that existed in the 1800s are gone.²⁰ Salt marshes—the most threatened and biologically rich of all wetlands—are the world's most productive ecosystem, generating ten tons of useful organic matter per acre, a rate 30 times the productivity of the open ocean.²¹ They provide food and shelter for birds, act as nurseries for fledgling fish, filter pollutants which run off land, provide flood control and trap sediment that would compromise water quality. About 77 percent by weight and 71 percent by value of all commercial fish species are dependent on salt marshes and other saltwater estuaries during some part of their life cycles. Those species were valued at \$5.5 billion in 1986.²²

Despite this tremendous value, an estimated 450,000 acres of wetlands are lost annually.²³ A 1992 National Academy of Sciences report recommends a gain of 10 million acres of wetlands by 2010.

But the cost of creating a wetland in 1983 ranged from \$2,000 to \$10,000/acre;²⁵ a high-end recent estimate contends some wetlands restorations can cost \$100,000/acre.²⁶

Mining lands. Of the six million acres of U.S. lands altered by sand, stone, gravel, coal, copper, iron and phosphate surface mining operations, four million need reclamation, according to 1985 estimates. Restoring these lands represents a \$30 billion project requiring 1.5 million person-years of employment, in 1985 figures. In 1978, restoration of one acre of a surface coal mine cost \$7,700.²⁷

Other ecosystems. Lands adjacent to roadways are frequently restored, to mitigate impacts of road-building; the state and federal Departments of Transportation are large users of restoration services in California. Native prairies in the midwest have been successfully restored. Erosion control following fires is another restoration field, although the effectiveness of current methods—which usually involve building roads into hillsides—is debatable. Anti-erosion controls for agricultural lands is another restoration field.

Market Potential

The environmental restoration field is in its infancy, with most environmental restoration work subsidized by the public sector. One environmental firm marketing manager projected California-wide ecological restoration work to be worth \$50 to \$100 million over the next five years, including construction. Another scientist estimated the market potential for restoring California wetlands alone at 1 million acres at a cost of \$500 to \$2,000/acre (a total cost of \$500 million to \$2 billion).²⁸ Millions of acres of California forests could be restored at approximately the same cost per acre. Virtually every California urban stream could benefit from restoration; there are approximately 75 small drainages that enter directly into San Francisco Bay, plus multiple tributaries of these upstream.²⁹ There are approximately 50,000 acres of former coastal wetlands in agriculture production in the Bay Area with potential for restoration, and another 350,000 diked former wetlands in the Delta in crop production.

Another growing segment of the restoration field is creating wetlands for tertiary wastewater treatment uses. A growing number of cities are requiring wetlands to be incorporated into water treatment facilities. Wetlands are also being constructed to capture and filter run-off from agricultural and pasturelands.

While the potential areas needing restoration are great, finding the necessary funding will be difficult. Costs per acre to restore natural resources may decline slightly, as the most efficient practices/government permitting processes are refined. Still, the work requires large investments. Approximately 20 different environmental rehabilitation programs are funded by California agencies; others are federally-subsidized. Current and potential sources of public sector restoration funding follow. (Note that while grantees are in most cases nonprofits or government entities, some of the restoration work in question is certain to be performed by private businesses.)

- The state Department of Water Resources funds an Urban Streams Restoration Program (USRP) which has awarded \$5 million statewide to restoration projects.³⁰ Grants of up to \$200,000 are available to partnerships of cities and nonprofit groups. (Community organizations or consulting firms may apply, but must find a nonprofit organization or local government to sponsor their proposals.) In 1994, \$370,000 will be awarded; in 1995, \$300,000.
- If the California Parks and Wildlife (CalPAW) initiative passes in June 1994, the USRP will receive \$14 million to disburse as grants for specific large-scale urban stream restoration projects, creating certain business for environmental restoration firms. Approximately \$4.2 million would be allocated to Bay Area streams. Additional monies would be allocated for Bay Area wetlands (\$40 million for acquisition and restoration), California urban forests (\$15 million) and salmon/steelhead conservation (\$5 million).
- The California Department of Fish and Game's Inland Fisheries Division is providing \$2.7 million in grants in 1994 for restoration of salmon streams.
- The Cigarette and Tobacco Tax Benefit Fund and the Commercial Salmon Stamp account are expected to provide some money for fish habitat restoration in 1994.
- The state Environmental Water Program is a \$60 million matching grant fund for restoration projects. Fisheries, riparian and wetlands habitat restoration/enhancement projects are eligible. Public agencies must apply for the grants, however much of the restoration work can be subcontracted to private firms.
- Although its 1994 funds are already allocated, the state Resources Agency provides \$10 million in annual grants to governments and nonprofits for urban forestry, roadside landscaping and land restoration.
- The California Coastal Conservancy's Resource Enhancement Program provides funds for watershed enhancement projects to government and non-profits.
- The Habitat Conservation Fund Program of the California Department of Parks and Recreation provides \$2 million annually in matching funds for wetlands and aquatic and riparian habitat.
- The Department of Forestry administers an Urban Forestry Grant Program, providing \$633,000 annually in funds to agencies and nonprofits for tree planting.

- The Bay Conservation and Development Corporation, the East Bay Parks District and the State Lands Commission all provide funding for wetlands restoration.
- President Clinton recently approved a \$1.22 billion appropriation nationwide—including estuary enhancement funds—for the State Revolving Fund program. No funds for the San Francisco Bay Area were included in this round, but future funding could be sought.
- A fund established by fees imposed on mining companies is expected to raise \$4 billion for reclamation of mining lands. (Approximately \$1 million in mine reclamation work creates 50 jobs.)³¹
- The National Marine Fisheries Service and the U.S. Army Corps of Engineers recently completed a study to determine the feasibility of a national fisheries habitat restoration program.
- Restoration is a new focus for agencies such as the Bureau of Reclamation and the Army Corps of Engineers (ironically the same that created many of the problems leading to the need for restoration).³²

In addition, corporations, foreign governments and nonprofits sometimes fund restorations following industrial accidents, when mitigation is required as part of a development permit, to preserve endangered habitat, to restore degraded lands, or even for profit:

- As part of the Sacramento River Project, the California Nature Conservancy is involved in a public-private partnership to preserve Llano Seco, a wildlife preserve in northern California. Plans include restoration of more than 10,000 acres of flood-prone rice, wheat and orchard land to marsh and oak forest.
- Southern Pacific Railroad has spent millions restoring the flora and fauna of a portion of the Sacramento River which was rendered lifeless following a deadly herbicide spill from an SP railcar in 1991.
- Louisiana Pacific, a timber-products company, has an agreement with the California Department of Fish & Game to restore fish-bearing streams on its property. The company contributes money, while the state provides subsidies for workers.
- PG&E has underwritten a \$3 million recovery effort to repair damage from a devastating hydroelectric dam failure in Lost Canyon (Fresno County) in 1982.

- In a joint venture, Levine-Fricke Restoration and Catellus Development Corporation plan to restore 1,800 acres of marine wetlands in the San Francisco Estuary in Solano County. The land is currently diked and used as cattle pasture. Tidal activity and habitat will be restored by removing dams and supplementing the sunken land with nonhazardous dredge spoils from dredging companies. Dumping fees will be comparable to ocean disposal and provide the profit incentive for the project. The Montezuma Wetlands will be turned over to a wildlife trustee organization once the restoration is complete.
- The government of Thailand is planning to plant 500 million trees in that country to celebrate the 50-year anniversary of the Thai king's ascension to the throne.

Environmental restoration creates jobs in an array of companies that supply those performing the actual work:

- Companies that provide Geographic Information Systems—computer software that allows ecological, environmental, restoration-oriented data to be converted from database form (rows, columns of numbers and words) to graphics, maps and pictures.³³
- Nurseries; they provide the root stock, seeds and trees used in restoration work.
- Companies providing equipment such as seed drills, fencing, tractors and other agricultural tools and equipment.

Job Potential

Restoration of urban natural areas is a largely untapped business with huge potential to create jobs and improve the liveability of California cities. Depending on policy decisions/priorities,³⁴ significant jobs could be created in restoration of urban forests, parks, creeks, hills, beaches and bays.

Many of the jobs created in environmental restoration are low-skill, minimum-wage positions. However, professional, high-skill jobs requiring advanced degrees are also created, including ecologists, botanists, land-use planners, hydrologists, engineers, biologists, sometimes archaeologists and landscape architects.

Forests and Streams. One forester estimates the ratio of skilled to unskilled labor in the forest restoration field at 1:100.³⁵ Stream and forest restoration tasks can include:

- interpreting historical aerial photos for past land-use practices, drainage patterns and major geomorphic features;
- developing a rehabilitation plan;
- laying out stakes and flags;
- removing trash and brush using chainsaws, machetes, axes, hoes and shovels;
- building wood bank overhangs, positioning boulders and placing large trees across streams to create spawning areas and protect fish from predators;
- building silt control devices. These include: digging large pits ten feet deep in streambeds where silt from erosion settles and is periodically removed; installing rock-filled wire baskets (gabions) that allow vegetation to take root; shoring up crumbling banks with weirs (low dams made from rocks or branches);
- building fish ladders for migrating fish;
- incubating, hatching, raising and releasing indigenous fish;
- removing logging decks, asphalt parking lots, culverts and roads (often using bulldozers, hydraulic excavators and dump trucks);
- building drains on former roadbeds to create runoff paths;
- recovering topsoil from below the road fill and replacing it on reconstructed hillsides;
- building fences;
- planting seedlings (mulching bank slopes, anchoring mulch with logs and other barriers, laying down protective ladders and planting vegetation by hand);
- planting trees (turning earth, loosening root mass/placing in hole, creating berms); and
- restocking with native aquatic insects.

Wetlands restoration tasks include:

- collecting, germinating and raising seeds from wetlands grasses in greenhouses;
- building fences;
- grading and filling, bringing in soil from comparable marshes;
- dam removal;
- channel digging;

- removing non-native plants;
- planting native grasses and trees;

Mining restoration tasks include:

- grading/bulldozing mining spoils to reestablish the approximate original contours and drainage of the land;
- spreading topsoil on the new surface;
- contour-furrowing the steeper slopes to slow runoff and help moisture retention;
- broadcasting seed via rangeland drill; and
- mulching slopes with shredded straw.

Environmental, Health, & Safety Issues

Some environmental restoration jobs can be dangerous (chainsawing, hauling heavy materials/equipment, driving/operating large machinery, other manual labor). Due to their physically demanding, high-risk nature, employees performing some unskilled labor jobs in the field can expect to have career longevity in the industry about equal to a wildland fire fighter's; approximately ten years.

Restoration activities are limited in their effectiveness. For example, with current technology it is difficult, if not impossible, to control acid mine drainage from underground mines, making true ecological restoration of such mined areas elusive if not impossible. Still, steps such as erosion prevention, planting of ground cover and other mitigation steps can help.

Environmental repair must be a final recourse, after all preventive measures have been exhausted. It should not be viewed as a technological fix which justifies consuming natural resources with disregard. "Accepting a restored ecosystem in partial trade for the destruction of another ecosystem means swallowing a decline in productivity, a radical change in species composition, or the possibility of outright failure."³⁸ An intact natural system has greater ecological value than one that has been restored from an altered state.

Infrastructure requirements

Because there is much overlap with environmental cleanup firms, environmental restoration companies also have minimal infrastructure requirements. Office space, equipment storage space, access to mass transit and parking are chief considerations. A closed military base location would provide good access for such firms to potential work sites.

Also, damaged wetlands are present on almost every northern California military base, making these sites potential laboratories for developing restoration techniques.

**Companies,
Agencies and
Associated
Organizations**

For lists of environmental technology/biology/ecology firms active in the state and Bay Area, and lists of the largest Bay Area environmental firms and engineering companies (compiled by the San Francisco Business Times), see the preceding section. Refer to Yellow Pages listings for *Landscape Architects and Environmental & Ecological Services*. For information about California forestry companies involved in restoration work, contact the California Forestry Association. A list of top Bay Area architecture/land use planning firms follows.

Adopt-a-Stream Foundation, nonprofit that trains local volunteers to revive and safeguard threatened streams. P.O. Box 5558, Everett, WA 98206.

A.F. Clewell, Inc., Route 7, Box 1195, Quincy, FL 32351. Environmental restoration firm. Contact: Andre Clewell, 904-875-3868.

Andropogon Associates, 374 Shurs Lane, Philadelphia, PA 19128. Landscape architecture firm restoring native woodlands, meadows and stream margins in urban and suburban environments. Contact: Leslie Sauer, 215-487-0700.

Eric and Steve Beckwitt, P.O. Box 29, North San Juan, CA 95960. Geographic information systems.

California Department of Fish & Game, 1416 9th Street, Sacramento, CA 95814. Issued a 1994 report on restoring salmon to Central Valley streams. Contact: Forrest Reynolds, 916-653-4729.

California Department of Parks and Recreation, P.O. Box 942896, Sacramento, CA 94296-0001. Contact: Odel King, 916-653-8758.

California Forestry Association, 916-444-6592.

Durbin-Durco, Inc., P.O. Box 8396, St. Louis, MO 63132, 314-993-4750. Fence building equipment.

Environmental Concern, 210 W. Chew Avenue, P.O. Box P, St. Michaels, MD 21663. Contact: Ed Garbisch, 410-745-9620.

Environmental Services Division, California Department of Fish and Game, 916-653-7664.

Environmental Systems Research Institute, Inc., Marketing Department, 380 New York Street, Redlands, CA 92373. 714-793-2853. Geographic information systems.

Environmental Water Program, California Department of Water Resources, P.O. Box 942836, Sacramento, CA 94236-0001. Contact: Phil Wendt 916-327-1660

David Hulse, Department of Landscape Architecture, School of Architecture and Allied Arts, University of Oregon, Eugene, OR 97403 503-686-3634. Geographic information systems.

Largest Bay Area Architecture Firms

Published November 5, 1993

Ranked by Bay Area 1992 gross billings			Bay Area 1992 gross billings	Percentage breakdown of gross billings by area of specialty ⁸	Total Bay Area architects	Total Bay Area full time employees	Areas of specialization	Notable Bay Area projects	Architecture	Engineering	Contract Mgmt.	Interior design	Landscape design	Master planning	Bay Area executive	Year founded
Rank ¹	Rank last	Company name Address Phone/fax														
1	1	Kaplan McLaughlin Diaz 222 Vallejo St., San Francisco 94111 (415) 398-5191 / (415) 394-7158	\$25,800,000 \$23,000,000	A: 80% D: 15% UD: 5%	95 136		Commercial, retail, health care, justice, hotels, academic, correctional, housing, urban design	Oakland Federal Building, Main General Hospital, Galaxy Theatre, San Francisco	*		*	*	*	*	Herbert McLaughlin	1983
2	3	Anshen + Allen 901 Market St., San Francisco 94103 (415) 882-9500 / (415) 882-9523	17,000,000 15,750,000	A: 90% D: 5% MPI: 5%	71 90		Health care, advanced technology facilities, universities	Stanford Green Earth Sciences, UC Berkeley Univ. Health Serv., Santa Clara Valley Medical Center	*		*	*	*	*	John E. MacAlister	1940
3	2	Helmut, Obata + Kassabaum Inc. 71 Stevenson St., Suite 2200 San Francisco 94105 (415) 243-0555 / (415) 882-7763	15,000,000 20,000,000	A: 55% D: 15% E: 18% L: 3%	59 108		Mixed-use developments, criminal justice, laboratories, corporate hq., investment office bldg., hotels, health care, transit, portland planning, campus planning	Apple R & D Campus, Cupertino, Services and Plant Biology Building, UC Berkeley, Wells Fargo Center, Sacramento	*	*	*	*	*	*	Patrick MacLeamy, William Valentine	1968
3	4	Gensler and Associates/Architects 600 California St., San Francisco 94108 (415) 433-3700 / (415) 827-3737	15,000,000 14,000,000	A: 35% D: 47% O: 18%	82 112		Strategic planning, interior design, retail, graphics, renovations	Moscone Center expansion II, Fremont's Funt, Novato, Apple Computer, Cupertino	*		*	*	*	*	James R. Follett	1986
5	6	Skidmore, Owings & Merrill 333 Bush St., 22nd Fl., San Francisco 94104 (415) 981-1552 / (415) 386-3214	12,000,000 14,000,000	A: 25% D: 25% E: 15% PL: 35%	58 80		Urban mixed-use, transportation, health care, hospitality, recreation, corporate and industrial, civic, hotels	Children's Hospital Oakland, Patient Services Pavilion, U.S. Court of Appeals renovation	*	*	*	*	*	*	Caroline Y. C. Woo	1936
5	6	The Ratcliff Architects 5855 Doyle St., Emeryville 94608 (510) 652-1972 / (510) 655-6654	12,000,000 12,000,000	A: 100%	56 82		Health care, laboratories, academic, housing rehabilitations and renovations, interior design	Veterans Administration Replacement Hospital, Palo Alto, San Mateo County Health Center	*		*	*	*	*	Christopher P. Ratcliff	1906
7	8	Esherick Homsey Dodge and Davis 2798 25th St., San Francisco 94110 (415) 286-9193 / (415) 286-3886	10,200,000 10,425,000	A: 80% D: 7% U: 6% ⁸	33 72		Aquariums, libraries, rehabilitation	Monterey Bay Aquarium, St. Dominic's Church, UC Berkeley DOE/Miller Library Complex	*	*	*	*	*	*	Joseph Esherick	1949
8	10	Robinson Mills + Williams 180 Pine St., San Francisco 94111 (415) 781-9800 / (415) 788-5218	8,750,000 9,000,000	A: 50% D: 50%	52 78		Office, custom interiors, retail, space planning, institutional, athletic	135 Main St., San Francisco, Temple Emanuel-EL renovation, S.F. Visual Arts Center, Yerba Buena G.	*	*	*	*	*	*	Thomas Garlin	1970
9	12	DES Architects + Engineers P.O. Box 3699, Redwood City 94063 (415) 364-6453 / (415) 364-2518	8,000,000 7,800,000	A: 80% D: 10% E: 7%	45 100		Office, health services, educational facilities, retail, industrial	Apple Computer Operations Center, Elk Grove, Reed-Pile Manufacturing Facility, Fremont	*	*	*	*	*	*	Keth Baudista	1972
10	7	Stone Maccacini Patterson One Market Plaza, Spear St. Tower, 4th Fl. San Francisco 94105 (415) 227-0100 / (415) 495-5091	7,944,843 8,198,519	A: 60% D: 5% PL: 10% MPI: 25%	57 110		Architectural design, master planning, programming, space planning and interior architecture	Stanford Univ. MSLMRS Bldg., UCSF, Mount Zion Cancer Research Facility, San Francisco The Terrace, Los Gatos	*		*	*	*	*	Michael D. Kelly	1927
11	16	MBT Associates 539 Bryant St., San Francisco 94107 (415) 896-0900 / (415) 495-5237	7,500,000 7,000,000	A: 80% D: 15% MPI: 5%	30 42		Research laboratories, computer facilities, healthcare, office headquarters, academic buildings	SF City Hall seismic renovation, GSU/USGS laboratories/office building, Menlo Park	*		*	*	*	*	Michael M. Heilmann	1964
12	15	NBBJ 130 Sutter St., 2nd Floor, San Francisco 94108 (415) 981-1100 / (415) 955-9393	6,500,000 6,000,000	A: 70% D: 10% PL: 5%	35 40		Health care, retail, higher education, laboratory interiors, planning	Gump's Store renovation, S.F. John Muir Medical Center master plan, Walnut Creek	*		*	*	*	*	John Pangrazio	1943
13	20	ED2 International 1660 Pacific Ave., San Francisco 94109 (415) 474-1400 / (415) 474-9110	5,800,083 4,812,962	A: 50% D: 30% O: 10%	44 50		Programming and design of R&D facilities, masterplanning and design of resorts, space planning	PG&E Learning Center Expansion, San Ramon, Merit YMAA, Robert Pitts Plaza, San Francisco	*		*	*	*	*	Frank B. Fung	1978
14	13	Whisler + Patri Two Bryant St., San Francisco 94105 (415) 957-0200 / (415) 777-4394	5,497,000 8,071,000	A: 50% D: 30% PL: 15% ⁸	18 20		Planning, architecture, interior design	Ritz-Carlton Hotel, San Francisco San Francisco Center, Hotel Nikko, San Francisco	*		*	*	*	*	Piero Patti	1954
15	14	Beckon Armitage + Ross Inc. 1650 Bush St., San Francisco 94109 (415) 441-7777 / (415) 441-6360	5,400,000 5,000,000	A: 55% D: 10% PL: 20%	36 56		Housing, redevelopment, film and entertainment facilities, hotels, senior housing, universities, restaurants	Sun Microsystems R & D Campus, Cupertino, Delancey St. Foundation Headquarters, San Francisco	*	*	*	*	*	*	James Mitchell	1980
16	16	VBN Architects 5011 14th St., Suite 300, Oakland 94612 (510) 763-1313 / (510) 465-1586	5,360,000 4,150,000	A: 90% D: 5% MPI: 5%	36 42		Education facilities, historic preservation, office buildings, transportation facilities	Oakland City Hall, Walter A. Haas School of Business, UC Berkeley, Amtrak Rail Station, Oakland	*		*	*	*	*	Noboru Nakamura	1960
17	15	Dahlin Group Inc. 2671 Crow Canyon Road, San Ramon 94583 (510) 837-8288 / (510) 837-2543	4,700,000 9,800,000	A: 75% LPT: 25% ⁸	30 36		Master planning, custom residences, production housing, mixed-use developments, recreational facilities	Silver Creek Valley Country Club & Community, San Jose, UCSF Military Ranch, S.F.	*	*	*	*	*	*	Doug Dahlin	1979
17	17	Hardison Komatsu Iwchik & Tucker 400 Second St., Suite 400, San Francisco 94107 (415) 541-0811 / (415) 541-0479	4,653,870 5,912,516	A: 80% D: 10% PL: 10%	18 26		Office buildings, elderly housing, schools, multi-family developments, water treatment facilities	Forum at Rancho San Antonio, Alhambra High School, 111 Jones Street, San Francisco	*		*	*	*	*	George Iwchik	1948
19	25	Studios Architecture 99 Green St., 3rd Fl., San Francisco 94111 (415) 398-7575 / (415) 398-3829	4,200,000 4,003,875	A: 35% D: 55%	22 32		Corporate interiors, law firms, high-tech firms	Wilson, Bonhart, Goodrich and Rosoff, Palo Alto, PMI Mortgage Insurance, S.F.	*		*	*	*	*	Dennis Robinson	1982
19	23	Anderson DeBartolo Pan Inc. 801 Montgomery St., 3rd Fl. San Francisco 94133 (415) 362-3145 / (415) 362-6872	4,191,682 4,287,587	A: 65% E: 35%	12 29		Health care facilities, university laboratory buildings, interior architecture and sports facilities	South Valley Hospital, Gilroy, Mercy Folsom Hospital, Kaiser-Fremont Hospital	*	*	*	*	*	*	Solomon Pan	1975
21	19	Sandoy & Babcock Inc. 1349 Larkin St., San Francisco 94109 (415) 673-8900 / (415) 441-3787	4,100,000 5,200,000	A: 64% E: 14% MPI: 10% ¹²	20 30		Residential, resort/hotel, mixed-use, adaptive use, housing, educational facilities, historic renovation	Inland Park, Belmont, Mercy Family Plaza, S.F., Del Norte Plaza, El Cerrito	*		*	*	*	*	Donald Sandy	1990
21	24	Simon Martin-Vegue Winkelstein Morris 501 Second St., San Francisco 94107 (415) 546-0400 / (415) 882-7098	3,884,247 3,290,712	A: 55% D: 40% PL: 5%	NA 50		Architecture, interior design, planning	New S.F. Main Library, Cooside Water Pollution Control Project, Hunters Point Shipyard	*		*	*	*	*	Diane Filippi	1985
23	Not on list	Interactive Resources 117 Park Place, Point Richmond 94108 (510) 236-7435 / (510) 232-5325	3,151,824 3,256,249	A: 45% E: 45% PL: 10%	15 28		Office and institutional design and planning, historic preservation, diagnostic and investigative services	Richmond Municipal Auditorium, Reston, Point Richmond Tech Center, Coit Tower Restoration	*	*	*	*	*	*	Thomas C. But	1973
24	Not on list	The Architects Collaborative 649 Front St., San Francisco 94111 (415) 392-4200 / (415) 392-4429	3,130,000 2,540,000	A: 55% D: 10% MPI: 5% ¹³	18 21		Educational facilities, libraries, retail centers, office, mixed-use, master planning	CSU Hayward - Contra Costa Center, State Library and Courts The Limited at Union Square	*		*	*	*	*	William J. Higgins	1945
25	Not on list	Crosby Helmsch Architects 35 New Montgomery St., Suite 950 San Francisco 94105 (415) 777-5444 / (415) 777-0844	2,200,000 2,200,000	A: 60% D: 30% PL: 10%	27 35		Offices, courts, multi-family housing, historic architecture, research labs, bio-medical facilities, hotels, town-ship, building evaluation studies	Abbot Labs, Santa Clara, Candlestick Park Renovation, U.S. Bankruptcy Courts, Stanford Park Hotel	*		*	*	*	*	Donald Crosby, Pamela Helmsch	1965

1. This List includes firms in the counties of Alameda, Contra Costa, Marin, San Mateo and San Francisco.
2. Last year's List was ranked according to companies' 1991 total billings in Bay Area offices.

3. A: architecture; D: design or interior design; E: engineering; UD: urban design; MPI: masterplan; LPT: landscape planning; PL: planning; L: landscape architecture; O: other.

4. LPT: 2%; MPI: 3%; U: 1%; PL: 3%.

5. Other: Graphics: 3%; Retail: 15%.

6. PL: 3%; MPI: 5%.

7. MPI: 1%; L: 1%; LPT: 1%.

8. U: 5%; MPI: 5%.

9. MPI: 10%; Other: Programming: 10%.

10. Other: Government Approval: 5%.

11. LPT includes MPI and PL.

12. O: 2%; PL: 5%; C: 5%.

13. L: 20%.

Researched by Mason O'Neal

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Inland Fisheries Division, California Department of Fish and Game, 1416 9th Street, Sacramento, CA 95814. Contact: Forrest Reynolds, 916-653-4729.

International Reforestation Suppliers, 2100 W. Broadway, P.O. Box 5547, Eugene, OR 97405. 800-321-1037. Provides natural resource management supplies (everything from shears, to waders to bud cap protectors).

Maasdam Pow'r-Pull, Inc., P.O. Box 6130, Burbank, CA 91510, 213-845-8769. Fence building equipment.

Native Seed Foundation, Route W, Moyie Springs, ID, 83845, 208-267-7938.

Phillip Williams & Associates, Pier 35, Embarcadero, San Francisco, CA 94133. Contact: Phil Williams, 415-981-8363. Consults on wetlands restoration; has performed approximately ten major wetlands restorations in California.

Resources Agency, 1416 Ninth Street, Suite 1311, Sacramento, CA 95814. Contact: Bill Borden, 916-654-2506.

Seymour Manufacturing Co., 500 N. Broadway, Seymour, Indiana 47274, 800-457-1909. Supplies post hole digging equipment.

Society for Ecological Restoration, 1207 Seminole Highway, Madison, WI 53711. SER, a trade association, publishes Restoration & Management Notes, SER News and Restoration Ecology. Contact: Don Falk, 608-263-7889.

Tubex Treeshelters, 75 Bidwell Street, St. Paul, MN 55107, 612-228-0535.

Urban Creeks Council, 1250 Addison Street, Suite 107c, Berkeley, CA 94702. Contact: Bruce Van Allen, 510-540-6669.

Urban Forestry Grant Program, Department of Forestry and Fire Protection, 2524 Mulberry, Riverside, CA 92501. Contact: Eric Oldar, 909-782-4140x146.

Urban Streams Restoration Program, California Department of Water Resources. Provides grants to help local groups restore streamside environments. P.O. Box 942836, Sacramento, CA 94236-0001. Contact: Earle Cummings, 916-327-1656.

Watershed Enhancement Program, California Coastal Conservancy, 1330 Broadway, Suite 1100, Oakland, CA 94612. Contact: Reed Holderman, 510-286-1015.

Wetlands Research Associates, Inc.

Interviews

Lonnell Britton, San Francisco Conservation Corps, 415-928-7322

Andy Clewell, Society of Ecological Restoration, 904-875-3868

Christine Shonewell-Cox, University of California/Davis, Environmental Planning & Management Department, 916-752-2088

Earle Cummings, Urban Streams Restoration Program, California Department of Water Resources, 916-327-1656

Ed Garbisch, Environmental Concern, 410-745-9620

Richard Harris, University of California/Berkeley, Extension Forestry Department, 510-642-3765

Reed Holderman, California Coastal Conservancy, 510-286-1015

Marc Holmes, Save San Francisco Bay Association, 1736 Franklin Street, Third Floor, Oakland, CA 94612. 510-452-9261.

Chapin Koch, Levine-Fricke, 1900 Powell Street, 12th Floor, Emeryville, CA 94608. 510-652-4500

Rob Leidy, U.S. EPA Region 9, 415-744-1970

Leslie Sauer, Andropogon Associates, 215-487-0700

Hsieh Wen Shen, Professor, University of California/Berkeley Engineering, 510-642-6774

Zach Willy, Environmental Defense Fund, 510-658-8901x236

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- ¹ Bezdek Roger, "Environment and Economy: What's the Bottom Line?", *Environment*, Sept. 1993, p. 28.
 - ² "Choosing a Sustainable Future," Report of the National Commission on the Environment, 1992, World Wildlife Fund, Washington, D.C. p. VI.
 - ³ Burstiner, Marcy, "Environmental firms raked in higher profits in '92," *San Francisco Business Times*, Oct. 1-7, 1993, p. 5B.
 - ⁴ Grant Ferrier, Editor, *Environmental Business Journal*, speech at Professional Environmental Marketing Association, Berkeley, California, July 27, 1993.
 - ⁵ Burstiner, Marcy, "Environmental-tech firms clean up in global market," *San Francisco Business Times*, Nov. 12-18, 1993, p. 2A.
 - ⁶ Burstiner, Marcy, "Environmental-tech firms clean up in global market," *San Francisco Business Times*, Nov. 12-18, 1993, p. 2A.
 - ⁷ Grant Ferrier, President, *Environmental Business International*, interview 1/19/94.
 - ⁸ Lenny Siegel, Pacific Studies Center
 - ⁹ Other areas include research programs, development of energy and conservation technologies and some government environmental expenditures.
 - ¹⁰ As with any regulatory streamlining process, Sierra Club supports full consideration of the environmental impacts and tradeoffs that may result from regulatory reform.
 - ¹¹ See footnote 10.
 - ¹² Initial analysis indicates serious deficiencies in the environmental, funding and community involvement provisions of the Science City proposal. For example, wetlands and other areas providing crucial habitat for endangered wildlife species would be destroyed and developed.
 - ¹³ Currently offered by City College of San Francisco.
 - ¹⁴ Berger, John J., *Restoring the Earth*, Alfred A. Knopf, 1985.
 - ¹⁵ Pollock, Sarah, "Consciousness of Streams," *California*, May, 1990, p. 78.
 - ¹⁶ Pollock, Sarah, "Consciousness of Streams," *California*, May, 1990, p. 80.

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

- ¹⁷ Rob Leidey, U.S. EPA, January 18, 1994.
- ¹⁸ When the Kissimmee River was altered in the 1960s, 45,000 acres of wetlands disappeared, along with 90 percent of the area's waterfowl. A pilot project showed that the birds return when natural water flows are restored. New York Times, March 24, 1992.
- ¹⁹ This last example included removal of 180 miles of logging roads and skid trails, planting of more than 684,000 trees and restoration of 26,330 acres. Source: Kiester, Jr., Edward, "California's Forgotten Park," This World, San Francisco Chronicle, January 30, 1994, p. 7.
- ²⁰ Kelley, Ken, "Habitat Restoration produces questionable results," National Fisheries magazine.
- ²¹ Berger, John J., Restoring the Earth, Alfred A. Knopf, 1985.
- ²² Kelley, Ken, "Habitat Restoration produces questionable results," National Fisheries magazine.
- ²³ Washington Post, Jan. 30, 1990.
- ²⁴ Christian Science Monitor, January 1, 1992.
- ²⁵ Berger, John J., Restoring the Earth, Alfred A. Knopf, 1985.
- ²⁶ Ibid.
- ²⁷ Ibid.
- ²⁸ Zach Willy, Environmental Defense Fund, 510-658-8901x236.
- ²⁹ Rob Leidey, U.S. EPA, January 18, 1994.
- ³⁰ Funding comes from Proposition 70 (California Wildlife, Coastal and Park Land Conservation Fund of 1988) bonds and environmental auto license fees.
- ³¹ Berger, John J., Restoring the Earth, Alfred A. Knopf, 1985.
- ³² Ibid., p. 151.
- ³³ GIS systems typically allow users to select a region on a map and retrieve the raw data related to it, to make changes to the map, etc. Systems now allow users in many locations to access information simultaneously through networks; for example, local groups and government foresters can share environmental records. GIS companies could see business generated by the massive new national Biological Survey being conducted by the U.S. Department of the Interior.
- ³⁴ Policy initiatives create many jobs in restoration. For example, as a result of the Mitchell Act and the Pacific Northwest Power and Conservation Act, 594 fish screens, 94 fish ladders and 25 salmon hatcheries on the Columbia River were financed.
- ³⁵ Richard Harris, Forestry Specialist, University of California/Berkeley Extension, November, 1993.
- ³⁶ Zuckerman, Seth, "Pitfalls on the Way to Lasting Restoration," Whole Earth Review, Spring 1990, p. 29.

Agriculture

Northern California is one of the world's premier wine-making regions. The city of San Francisco hosts the country's competitive restaurant industry, with over 3,000. A significant activity in agriculture, including grape growing, is wine-making and related.

Agriculture is a high growth industry with a growing presence in the economy. The industry is growing rapidly and is one of the most important sectors of the economy. The industry is growing rapidly and is one of the most important sectors of the economy.

The industry is growing rapidly and is one of the most important sectors of the economy. The industry is growing rapidly and is one of the most important sectors of the economy. The industry is growing rapidly and is one of the most important sectors of the economy.

The agriculture industry is a major sector of the economy. The industry is growing rapidly and is one of the most important sectors of the economy. The industry is growing rapidly and is one of the most important sectors of the economy.

Type of Industry/Business

Farming
 and aquaculture

Description of Industry

Farming is a major sector of the economy. The industry is growing rapidly and is one of the most important sectors of the economy. The industry is growing rapidly and is one of the most important sectors of the economy.

Farming is a major sector of the economy. The industry is growing rapidly and is one of the most important sectors of the economy. The industry is growing rapidly and is one of the most important sectors of the economy.

Agriculture/Aquaculture

Section VI

Introduction

Northern California is one of the world's premier restaurant markets. For example, the city of San Francisco hosts the country's largest, most competitive restaurant industry, with over 3,000. A significant portion of this industry is upscale, creating great demand for premium quality organic produce and seafood.

Aquaculture is a high growth industry which, although it has been practiced in some form for millennia, has been present in the "modern" form since the middle of this century. There are two distinct types of aquaculture in practice today, the growth of fish (which includes fin-fish and shellfish) and the growth or harvesting of vegetation. These two types of aquaculture are practiced throughout the world.

Fish can be grown with less grain per pound of consumable meat than red meat or poultry; there is higher efficiency of feed to eatable product in farming fish as compared to other animal farming. This is a significant advantage to those concerned about the earth's abilities to sustain growing populations, and environmental problems associated with livestock agriculture (degraded rangelands, silted estuaries, loss of topsoil, methane gas pollution, etc.).

The agriculture/aquaculture businesses described below are the closest to integrated, "closed-loop" production of any described in this report. That is, even the waste materials they generate can be used as resources (fertilizer, soil amendments, worm food), either by other businesses or in their own operations. Other companies' waste (manure, compostable waste) can also be used. One company's operations creates business opportunities for another. Moreover, agriculture and aquaculture at former military bases hold high potential for low environmental impact, sustainability, local entrepreneurship and long-term market, job and revenue creation.

Types of Industry/ Business

Fish farming
Sea vegetation farming

Description of industry

Fish farming is now at a stage where large-scale, mechanized growth is common. Over thirteen percent of the total world's fish consumption is farm-grown fish. About 70 percent of farm-grown fish is fin-fish, 24 percent is mollusks, and six percent is crustaceans. One-third of the farm-grown fish is of the salt water variety, while two-thirds is fresh water.

In 1989 fish-farming was a \$1.1 billion industry in America¹, and by 1991, world production of farmed fish reached 13 million tons². In the U.S.,

salmon are farmed in Maine and the Pacific Northwest, shrimp in Texas, trout in Idaho, catfish in Louisiana and Mississippi, and tilapia in Maryland.

The aquaculture industry in California is unique in its diversity. Among the major species grown in the state are oysters, abalone, mussels, salmon, trout, catfish, bass, sturgeon and tilapia. Farms are spread throughout California without major centers of concentration, although Riverside County probably has the most fish farming of any area in the state.

Water vegetation, typically labeled as "seaweed", is harvested throughout the world. The Japanese have a \$1 billion seaweed industry, which is used for sushi and other foods. A freshwater type of vegetation named duckweed, or khai-nam, is harvested in Thailand and other locations. Kelp is harvested off the California coast, not for food but for use in a variety of products, including textiles and cosmetics. Mendocino is the west coast center of the U.S. sea vegetable industry, where a dozen different types of seaweed are harvested for consumption.

Fish are farmed in several ways. One method is through creating artificial lakes or pools by building dikes or walls and flooding the area inside. Another is building holding bays on the edge of lakes and rivers. A third method is to build holding tanks, sometimes inside large buildings or warehouses, similar to a large aquarium. These are all generally methods of fresh water farming. In coastal (salt water) fish-farming, the fish are often grown in floating pens or netted areas in bays or in the open ocean. The fish are provided with food, often pellets manufactured specifically for the application. Drugs and antibiotics are often provided to avoid or treat disease. In many cases the holding ponds or pens are periodically emptied, cleaned and sterilized often using chemicals for disinfection.

The above methods are used for fin-fish and crustacean-type shellfish. Bi-valve shellfish such as clams and oysters are often farmed by seeding natural beds with hatchery raised larvae and then harvesting using traditional methods. Another method used for bivalves is to seed larvae onto ropes or chains containing old shells, which can then be harvested fairly easily after the shellfish are mature.

The waste silt produced by fish farmed in a condensed environment, such as a pen or tank, can be used as an organic fertilizer, thus turning a cumbersome by-product into a potentially valuable side-product.

Sea vegetation is sometimes hand-harvested directly from its natural growth environment, rocky coves along the ocean coast. Crops harvested by hand in Mendocino are fucus, grapestone, sea cabbage, sea lettuce and nori. "Offshore" vegetable farming is conducted using floating pens which the plants are attached to and grown. In both methods of farming the harvested portion is trimmed off the plants, leaving a base which will continue to grow, for a continual harvest.

Duckweed, or khai-nam, is a tiny fresh water aquatic weed which, as well as being an excellent source of protein, can be used to treat waste water. This plant has been used in Thailand for generations as a food source by rural families (the name khai-nam translates to "poor man's food"). Duckweed has recently been approved by the EPA for use in waste water treatment systems. The plant feeds on certain wastes, including human, and has a rapid life cycle which results in fast reproduction of the plant if fed a continual waste stream. It is being used as a supplement and even as a substitute for conventional technology waste treatment. It is possible that the waste treatment and food generation functions can be provided simultaneously by this plant in the proper environment.

Market Potential

Aquaculture is a high growth industry with strong market potential for the Bay Area as well as the national and global markets. World consumption of fish (almost 100 million tons annually) exceeds that of beef and chicken combined.³ In tandem with this high demand, commercial fishing has developed to the point where the productive capacity of the world's natural fisheries has been reached and even exceeded. Obtaining more from these fisheries will mean a decrease in capacity in the future. This has resulted in a two-hundred mile international zone off the coast of all countries where foreign fishing is regulated. In addition, national governments have been tightening regulations within their own waters.

In the U.S., there is a higher demand for fish as per capita consumption of fish has increased while per capita consumption of meat has decreased. The per capita fish consumption rose 24 percent during the 1980s to 15.9 pounds per person per year. This number is expected to increase even more throughout this decade. Coupled with an increase in population, this growth means that the natural supply of fish will not be able to meet the consumption demand of the world's population. It is a basic premise that the further growth in fish consumption must come from farming.

The aquaculture industry is presently growing at approximately 15 percent per year in both the U.S. and in the state of California. Attracted by the growth potential of the industry, many major American food companies are entering the aquaculture industry. There is a high level of research and development aimed at facilitating commercialization of the industry. Many research centers are developing better methods for farming and methods for farming more species of fish. It is likely the aquaculture industry will continue to grow and expand in the near future.

But aquaculture has a high vulnerability to price fluctuations. Overproduction of catfish resulted in a glut in 1990 which lowered prices considerably, but producers are keeping a closer eye on supply/demand economics now.

Job Creation Potential

The fish farming industry has strong job-creation potential.⁴ Most aquaculture jobs are skilled labor positions, with a small percentage of professional positions.⁵ Professional staff required include chemists and biologists, as well as manufacturing process engineers (mechanical or chemical). The skilled labor positions include tasks requiring some training, such as taking water quality samples, feeding fish and harvesting fish.

A typical high density fin-fish farm (the type suited for urban environments) would grow fish in tanks inside buildings. A farm which is sited on a total area of ten acres (including parking lots, support buildings, etc.) would produce approximately four million pounds of fish per year. This plant would employ approximately forty skilled laborers plus five staff and professional positions.

Environmental, Health & Safety Issues

Drugs often used to prevent or treat diseases in fish can linger in the fish when they are sold for consumption. Another concern is that these drugs may accumulate in the areas where the fish are bred. There is also concern that use of antibiotics may cause the bacteria they are used against to develop resistances which may impact nearby human populations in the future.

A second issue is that some farm-bred fish escape into the local environment. These fish compete with native populations, potentially upsetting the ecosystem. Farmed fish tend to be inbred, therefore when they mix with the indigenous population they can dilute the gene pool of the indigenous population by introducing undesirable characteristics.

Excessive wastes from fish farming can be another problem. Concentration of wastes can become toxic. Also, non-toxic organic wastes cause algae overgrowth, depleting oxygen and harming other life in the area.

One of the most publicized issues of aquaculture has been the clearing of mangrove forests and other natural coastal ecosystems, thus drawing criticism from environmental groups which aquaculturalists have counted on as allies. Aquaculture has also encountered resistance from local populations where new sites have been proposed for these reasons as well as for concern that the aquaculture operations would destroy the aesthetics of local environments.

On the positive side, fish farming uses resources such as grain, soybean, fresh water and land far more efficiently than poultry, pork and beef production. Catfish, for example, require only 1.75 pounds of feed to yield a pound of weight; by contrast, feedlot cattle need seven pounds of grain to gain a pound. Pigs need four pounds of feed and chickens about two for a one pound gain.⁶

Nevertheless, fish farming must be considered as an additional source of seafood, not a substitute for wild fish. There must be continued, concentrated efforts to address the threats to ocean and stream resources, and the overfishing that have resulted in extinctions/near extinctions of native fish.

Infrastructure requirements

A well-established industry exists for supplying equipment (nets, tanks, etc.) and food pellets for fish farming. Several companies exist in California for both equipment and feed, although California is not self-sufficient and farms in California have equipment and feed supplied from companies throughout the country.

Aquaculture holds potential to create a range of skilled labor and professional jobs in northern California. High-density fin-fish farming would be particularly well-suited to vacated warehouses and workshops at closed military bases. The huge restaurant and consumer markets of San Francisco, Oakland and Sacramento make northern California locations attractive to fish farm companies. Although the number of employment positions to be created is not great, aquaculture does offer immediate employment opportunities in a growing, environmentally safe industry for people of varying education levels.

Companies, Agencies and Associated Organizations

Refer to the California Aquaculture Association Member Directory/ Products and Services for a comprehensive listing of businesses involved with this industry: CAA, P.O. Box 1004, Niland, CA 92257, 619-359-FISH.

Abalone Unlimited of Guadalupe, California. Contact Micheal Gaul, chairman. Produced about nine million pounds of abalone in 1992.

Aquaculture Technologies Ltd., Lafayette, Louisiana. Contact Greg Lutz. Grows striped bass.

Aquafuture, Montague, Massachussetts. Created a system for growing fish which cleans water in the process.

Aquamar Inc., Pocomoke, Maryland. Contact Jerry Redden, general manager. Grows talapia and striped bass.

Aquatic Systems Inc., San Diego. Contact Jim Carlborg. A pioneer and leading producer of striped bass.

Clear Springs Trout Inc., Boise, Idaho. Contact Larry Cope, president. One of leading trout producers.

Country Skillet Inc., Isola, Mississippi. Contact Dick Stevens, president. One of largest processors of catfish.

Delta Pride Catfish Inc., Indianola, Mississippi. One of largest processors of catfish.

Sea Farm Washington. Contact John Forster, general manager. One of country's largest salmon farms.

Solar Aquafarms Inc., Sun City, California. A leading grower of talapia.

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California Aquaculture Association., P.O. Box 1004, Niland, CA 92257 (619) 359-FISH. Contact: Mr. George Ray

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"Gone Farmin'", Jay Harlow, San Francisco Chronicle, October 27, 1993.

"Growing Fish in Fields", Hal Kane, World Watch, September/October 1993.

"Harvest of the Ocean Garden", Charles Hillenger, Los Angeles Times, December 25, 1989.

"Member Directory Products and Services" by the California Aquaculture Association.

"Puget Sound Fish Farms Challenged", Keith Schneider, New York Times, July 8, 1989.

"Sparing the Rod, Seeding the Pond, Americans Grow more Fish to Eat", Linda Garmen Weimer, New York Times, January 20, 1991.

Vital Signs 1993, Lester Brown, Worldwatch Institute.

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Types of Industry/Business

Urban organic farming
Organic landscaping & nurseries
Composting
Worm breeding

Description of industry

Urban Organic Farming

Some urban farming utilizes "raised-bed" farming, a technique particularly relevant to converting military bases, where large areas of soil are contaminated by toxics.⁷ "Raised-bed" farming is a method that utilizes the construction of large planter boxes in the form of long beds. Farmers control the integrity of the original soil plus the continuous input of soil amendments and fertilizers. Through large scale composting (isolated from any contaminated soil), the soil used in the raised beds can be naturally controlled and enhanced. Compostables could be obtained from the hotel and restaurant industries, and natural fertilizer from fish farms or stables.

The greatest market challenges for urban organic farming are potentially high capital costs (greenhouses, climate control, raised beds) and drastically fluctuating prices for produce targeted toward upscale restaurants. The latter variability is a result of seasonal and "trend" demand factors. Success of such a venture will therefore rely as much on strong business management as state-of-the-art farming techniques.

Urban organic farming at one closed base in particular may have a long-term potential advantage over non-local competitors in distribution outlets. At Hunters Point, the potential for a planned Third Street light-rail train system to establish "truckless" distribution—with bicycle-drawn trailers linking the farm(s) to the train and the train to purchasers—could be considered. Or produce could be directly delivered by light-rail to transfer outposts located near Market Street. The resulting cost and environmental savings (trucking expenses, reduced air pollution, less consumption of fossil fuels) represent significant marketing advantages for such a business.

The following projections⁸ can be made about an urban organic farming operation for decommissioned bases.

Size: Assume 5 acres to be sufficiently large enough to support large-scale composting and be rather labor-intensive.

Markets: Upscale restaurants and natural food stores.

Labor: 120 full time year round employees and an additional 120 (240 total) during summer months.

Rent: Undetermined, although it must be cheaper than other urban lots.⁹ Subsidized rent would substantially boost the viability of this project.

Revenues: potentially more than \$4 million annually

Other crops meriting consideration are flowers, herbs and trees. Cultivation would take place in greenhouse structures. A marketing advantage would be created by growing strictly California native flowers, trees, herbs and seeds. Outlets would be florists, restaurants, non-profit tree planting organizations, grocery stores, environmental restoration firms and utilities. (For example, the Sacramento Municipal Utilities District is a large purchaser of trees which they plant near homes to create shade and reduce energy consumption from air conditioners.)

Capital investments and operational costs (to build, heat, light and maintain the greenhouse(s)) for this type of cultivation would be substantial. However, revenue yields could make it feasible.

Given the known and unknown levels of hazardous waste in soils at closing military bases, raised bed farming could be an efficient use of the land. Plots could be relatively small, or even dispersed, to suit space requirements.

Organic landscaping and nurseries

Another feature of urban organic farming is its potential for creating sustainable jobs in "spin-off" industries. A **landscaping** business providing planning/building/consulting/maintenance for other community gardens (for profit or not) in urban areas is one logical offshoot.

Possible Revenue: \$300,000/yr.

Labor: 20 full time people.

(Rough estimates based on phone poll of local landscaping firms.)

Nurseries are a strong element of the California economy; the state has nearly 3,000 producing \$1.9 billion in products annually. Nursery

production gets the best return in terms of dollar value per acre of any agricultural land use.¹⁰ Urban areas are host to the largest number of these businesses. Acreage required for the state's most lucrative nurseries ranges from 25 to 2,600 acres.

Market Potential: The increasing interest in using houseplants for indoor air pollution control, and in environmental restoration projects utilizing native plant species, make nurseries a likely growth industry. However, because it produces non-necessity products, the industry may be vulnerable to economic downturns.

Large scale composting/worm breeding

Large scale composting as an accompaniment to urban organic farming has multiple benefits: eliminating reliance on environmentally harmful fertilizers; reducing farming input costs; contributing to very high quality/value produce; and producing packaged soil and soil amendments for sale at local nurseries.

The most logical manner to collect compostable material is to seek out agreements from a few large sources. For example, Rainbow Worms of Davis, California gathers left-over rice hulls from a local rice manufacturer and feeds them to their worms. Securing a source of free (or very inexpensive) compostable material should not be a problem for any of closing the northern California military bases. For example, San Francisco's restaurants could provide more than enough vegetable waste for a very large composting operation.

Another spinoff related to composting is **large scale worm breeding**, with potential for additional revenues from worm and worm castings sales to nurseries and bait shops. (Worms and rabbits eat organic waste and convert it into nitrogen-rich castings. Both worm and rabbit castings make excellent soil amendments. Worms are inexpensive and easily shipped through the mail anywhere in the country.)

To create a "closed-loop" worm composting/ breeding operation, little space is needed: 1/2 acre dedicated to composting, 1/4 acre (3630 sq. ft.) to worm composting and 1/4 acre to normal yard composting. A mature sustainable ratio of pounds of worms to a square foot is .57 and each pound of worms eats eight pounds of organic waste per month.¹¹ The one-quarter acre worm composting space will maintain approximately 2000 pounds of worms and convert 16,000 pounds of organic waste into 1,600 pounds of worm castings.

Since worms double their population every month, it would be feasible to harvest and sell half the stock of worms per month without affecting the balanced population. Thus, 1000 pounds of worms per month could be harvested and sold. The potential value of a worm composting operation can be measured either as savings on inputs into farming project or as sales revenue.

worm sales: 1,000 lbs. worms/month X \$6/lb. = \$6,000/mo.

or \$72,000 per year.

worm castings: 1,600 lbs. castings X \$5/lb. = \$8,000/mo.

or \$96,000 per year.

Considering that this is only one half of the composting picture we could double the worm castings value and add in worm sales revenues in order to attain an estimate of the value of the entire composting project.

Total Value: 72,000 + 2 X (96,000) = \$264,000 per year.

Labor: 5 full-time people

Types of Industry/ Business

Treeless paper fiber farming
Treeless paper manufacturing

Description of industry

Conventional paper production is among the industrial world's most polluting and resource-intensive processes. Paper manufacturing has significant impacts on an extremely broad range of environmental problems including deforestation, global warming, ozone depletion, air and water pollution and loss of biodiversity. The deteriorating patchwork of remaining American natural (non-tree farm) forests, and the environmental damage caused by traditional pulping processes call for alternative sources of paper in our society.

Treeless paper manufacturing

Kenaf is a proven substitute for paper pulp from trees. The U.S. Department of Agriculture studied over 500 plants for their fiber qualities and commercial potential and chose kenaf as the most viable fiber plant for U.S. paper production.

Kenaf is a relative of the okra plant that can grow 15 feet high in only five months with little need for water, fertilizers and pesticides. Due to the low lignin content of kenaf, fewer chemicals are required to convert it to pulp. Using fewer chemicals in turn reduces waste water contamination. Also, because it is naturally whiter than wood, kenaf requires less bleaching, if any. If bleaching is demanded, chlorine-free bleaching is well suited to kenaf processing.

USDA field trials show that kenaf can yield three to five times more fiber per acre per year than southern pine; and pine trees take twenty years to mature. Moreover, because of its low bark content, kenaf loses less of its fiber weight in the manufacturing process. Normal tree fiber loses approximately 40 percent of its weight while kenaf loses 30 percent. For all these reasons, a switch to kenaf-based paper could be a bold attempt at reducing dependency on forests for paper.

In addition to being a source of pulp for all grades of paper (grocery bags, newspapers, office, resume, etc.) kenaf is used as:

- Animal food;
- Chicken litter;
- Particle/fiber board;
- Sewage sludge collection filters;
- Molded/paper packaging;
- Plastics additive;
- Potting soil; and
- Seed bedding and oil.

Market Potential

A new executive order requires all federal government agencies to buy paper containing at least 20 percent post-consumer waste by 1995, increasing to 30 percent by 1999. San Francisco has its own recycling ordinance requiring city departments to purchase recycled paper with post-consumer content. Moreover, public opposition to cutting down trees for use in paper products is increasingly vocal, resulting in many public forest lands being put off limits to harvest.

These and other factors point to rising demand for environmentally safer paper, especially treeless paper containing recycled paper fiber, for multiple generations to come. Population growth and world-wide increasing literacy rates also support this paper demand growth projection.

Hemp - Not Just for Potheads Anymore

An acre of hemp, the plant stalk of the marijuana flower, produces four times as much paper as an acre of pine trees. New strains of the plant are virtually devoid of the chemical—THC—that makes marijuana a mind-bender. Low-THC hemp is currently grown in experimental fields in France and harvested for manufacturing cigarette papers. Tree Free Paper in Oregon imports bleach-free hemp paper from China, made with just 10 percent of the chemicals needed for wood pulp paper.

Hemp grows well in the San Francisco Bay Area, making the possibility of local, side-by-side growing and manufacturing of hemp-based paper at closing bases more than a Haight-Ashburian's dream. Paper produced by commercial hemp operations could potentially cost 25 to 50 percent less than wood-based paper due to inherently simpler processing—especially with localization of agricultural production, manufacture of paper and distribution.

A very preliminary estimate indicates substantial revenue opportunity for a kenaf facility. At peak production with the most modern facility, up to 1000 tons of kenaf paper per day could be manufactured. Assuming a five day work week, that would equate to 5000 tons per week or 260,000 tons of paper per year. One ream of normal 20 pound paper weighs five pounds. This would produce 400 reams per ton or 104,000,000 reams of paper per year.

Depending on the success of cost-minimizing techniques, such as localization of manufacturing, to lower production costs, total revenues for such a kenaf paper factory might be in the hundreds of millions annually. A substantial portion of these revenues would be spent on buying the kenaf or recycled fiber as the inputs into the paper manufacturing process.

There are critical concerns to address to determine the appropriateness and feasibility of kenaf paper processing at sites near San Francisco Bay or the Sacramento River Delta. Paper plants are large capital investments. Currently, the cheapest kenaf paper sells for about \$12.50 per ream (500 sheets). Large contracts and mass production will be necessary to drive this cost down. Other conditions which would have to be met for a kenaf facility to be viable include:

- Kenaf would have to be grown in large-scale production in the Delta region;
- A reliable source of recycled paper pulp would have to be secured for blending with kenaf;
- Further research would be needed to confirm that the facility should be located closest to the markets for kenaf paper, not closest to the raw material supply; and
- A modern paper mill designed exclusively for kenaf would have to be permitted and built.

Job Potential

A new paper manufacturing plant could employ **more than 300 new workers** (not including construction jobs) and would sustain increasing labor growth as demand for treeless paper increases. Average labor wages for paper mill workers range from \$12 to \$15 per hour and generally include all benefits.

**Environmental,
Health and
Safety Issues**

One kenaf industry expert¹² believes that a new, modern manufacturing plant designed exclusively for kenaf would meet or exceed all environmental regulations. He also contends that some of the fear of the pulping process comes from the historical record of paper mills before proper environmental regulations were implemented, and that with modern technologies there is little risk of the treated effluent polluting nearby bodies of water.

Further research is needed to evaluate the precise potential environmental impacts of a kenaf operation.

Kenaf agriculture

Although kenaf is currently being grown almost exclusively in the southern United States and primarily New Mexico, it would likely grow well in the Central Valley, near Sacramento/Davis or anywhere in the Delta region.¹³

Significant agricultural opportunities for sub-contracting farmers at closed military bases in the nearby Delta/Central Valley regions could be created by kenaf paper manufacturing. Kenaf annually produces ten tons of raw fiber per acre. Ten tons of kenaf will produce seven tons of paper. If the paper is a blend of 50 percent kenaf and 50 percent recycled fibers, then 130,000 tons of kenaf paper would be required with the present assumptions. 130,000 tons divided by seven tons per acre equals almost **19,000 acres** of land that would be required for kenaf agriculture.

**Companies,
Agencies and
Associated
Organizations**

Fresh Start Farms, contact: Ruth Brinker.

Rainbow Worms, 24700 County Rd. 95, Davis, CA 95616 ph. (916) 758-9906.

Tree-Free Eco-Paper, Portland, OR. Contact: Paul Stanford, ph. (503) 690-4052

Urban Habitat Program. A program of the Earth Island Institute. 300 Broadway, Suite 28 San Francisco, CA 94133-3312. Contact: Henry Holmes or Martha Matsuoka.

Yahoo Compost Center and Ecology Center, 968 Valencia Street, San Francisco, CA (415) 282-WORM. Director Fernando Pastor.

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- Von Lokum, Vicki. Kona Kai Urban Farm. ph. (510) 486-0289.

¹ "What's New in Aquaculture," Sheryl Jean, New York Times, v138, sec3 (Sun, August 6, 1989) Page F13.

² "Growing Fish in Fields", Hal Kane, World Watch, September/October 1993, Pages 20-27.

³ Brown, Lester, Vital Signs 1993, Worldwatch Institute, p. 118.

⁴ Ecuador presently has more than 90,000 people employed by the shrimp-farming industry, while

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

Norway has more than 50,000 people employed in the salmon industry, examples of two fairly small countries which have become intensely involved in the aquaculture industry.

- ⁵ Several new aquaculture programs and departments have been started in American universities in the last five years. In California alone the following programs exist: UC Davis has an Aquaculture and Fisheries Program; Humbolt State University has a Department of Fisheries, College of the Redwoods has an Aquaculture and Fisheries Technology program, UC's Bodega Bay Marine Lab has an aquaculture program, and Cal State University in Chico has an aquaculture program.
- ⁶ Brown, Lester, Vital Signs 1993, Worldwatch Institute, p. 119.
- ⁷ Any potential impacts of air pollution on crops also merit study.
- ⁸ Developed in consultation with urban farmers with smaller scale operations.
- ⁹ For example, through an agreement with the San Francisco Redevelopment Agency, Fresh Start Farms, a nonprofit organic farm in the city's Western Addition, leases a quarter-acre lot for \$1 a month. Fresh Start Farms employs the homeless to grow organic produce for sale to upscale restaurants.
- ¹⁰ Data Harvest, Sacramento agricultural information service. Bigham, Joe, "California's nurseries blooming," San Francisco Examiner, Jan. 24, 1994.
- ¹¹ Yahoo Compost of San Francisco, a local worm breeder and worm box manufacturer
- ¹² Thomas Rymaza of KP Products
- ¹³ According to Thomas Rymaza, president of KP Products, the country's premier kenaf grower

TOP 25 NURSERIES

California's 25 largest nurseries, followed by acreage, main crops, counties in which the company operates and owner or principal officer. Ranked according to gross receipts annually.

\$20 million-\$50 million

- ▶ 1. Monrovia Nursery Co. Inc., Azusa, Los Angeles County. 1,600 acres. Shade trees, shrubs. Los Angeles, Tulare, Ventura. Miles Rosedale, CEO.
- ▶ 2. Hines Nurseries Inc., Irvine, Orange County. 644 acres. Trees and shrubs. Orange, Solano. Doug Allen, president.
- ▶ 3. Bear Creek Production Co., Wasco, Kern County. 2,611 acres. Roses. Kern, Ventura. Bear Creek Corp., owner.
- ▶ 4. Nurserymen's Exchange Inc., San Francisco. 182 acres. Orchids. San Francisco, San Mateo. Carl Pearlstein, chairman.

\$12 million-\$19.9 million

- ▶ 5. Color Spot Inc., Richmond. 445 acres. Evergreens, trees, shrubs. Contra Costa, San Joaquin. Don Henshaw, president.
- ▶ 6. Pacific Earth Resources, Camarillo, Ventura County. 1,073 acres. Sod. Kern, San Benito, Stanislaus, Ventura. Richard and Elizabeth Rogers, owners.
- ▶ 7. Kitayama Brothers Inc., Watsonville. 342 acres. Flowers. Alameda, Santa Cruz. Tom Kitayama, president.
- ▶ 8. El Modeno Gardens Inc., Irvine, Orange County. 235 acres. Ornamentals, decorative plants. Orange. Peter Groot, president.
- ▶ 9. Sunnyside Nurseries Inc., Hayward. 35 acres. Flowers. Alameda, Monterey. Vance Yoshida, president.
- ▶ 10. Paul Ecke Ranch Inc., Encinitas, San Diego County. 25 acres. Poinsettias. San Diego. Paul Ecke Jr., president.
- ▶ 11. Flynn Rainbow Nurseries Inc., Fallbrook, San Diego County. 243 acres. Trees, shrubs, fruit and nut trees. San Diego. Donald Flynn, chairman.

\$8 million-\$11.9 million

- ▶ 12. Bay City Flower Co. Inc., Half Moon Bay. 35 acres. Cacti, succulents. San Mateo. Harrison Higaki, president.

- ▶ 13. Francis L. Norman's Nursery Inc., San Gabriel, Los Angeles County. 200 acres. Broadleaf evergreens. Los Angeles, San Joaquin. Charles Norman, president.
- ▶ 14. Sun Valley Floral Farms, Arcata, Humboldt County. 200 acres. Cut flowers, bulbs. Humboldt. Leendert De Vries, manager.
- ▶ 15. Norcal Nursery Inc., Red Bluff. 611 acres. Strawberries. Lassen, Merced. John Sakuma, president.
- ▶ 16. Evergreen Distributors Inc., San Diego. 202 acres. Most nursery products. Riverside, San Diego. Mark Collins, chairman.
- ▶ 17. Lassen Canyon Nursery Inc., Redding. 480 acres. Strawberries. San Joaquin, Shasta, Siskiyou. Kenneth Elwood, president.

\$6 million-\$7.9 million

- ▶ 18. Pajaro Valley Greenhouses Inc., Watsonville. 40 acres. Flowers. Monterey. Arne Thirup, president.
- ▶ 19. Pacific Nurseries of California Inc., Daly City. 104 acres. Trees, shrubs, ground cover. Alameda, Santa Clara, San Mateo. Anthony Tarlock, president.
- ▶ 20. A-G Sod Farms Inc., Riverside. 600-plus acres. Sod. Riverside, San Benito, San Diego, San Joaquin. John Addink, president.
- ▶ 21. L.E. Cooke Co., Visalia. 950 acres. Fruit and nut trees, raspberries. Tulare. Robert L. Ludekens, president.
- ▶ 22. Seatree Nurseries Inc., East Irvine, Orange County. 95 acres. Evergreens. Orange. Robert Seat, president.
- ▶ 23. S.B. Nickerson Nursery Inc., Fallbrook, San Diego County. 51 acres. Evergreens. San Joaquin. Joseph and Judy Rico, owners.
- ▶ 24. Mainland Nursery Inc., Lodi, San Joaquin County. 35 acres. Poinsettias. San Joaquin. John Merrill, president.
- ▶ 25. DeVor Nurseries, Freedom, Santa Cruz County. 713 acres. Roses. Santa Cruz, Kern. Omer Schneider, president.

SOURCE: Compiled by Data Harvest for the Associated Press.

EXAMINER GRAPHICS

Introduction

California's share of the nation's population is 21 percent of the nation's population, but its share of the nation's population is 21 percent of the nation's population. The number of people living in California is approximately 20 million, or about 21 percent of the nation's population. The number of people living in California is approximately 20 million, or about 21 percent of the nation's population.

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Advanced Transportation

Section VII

Introduction

Transportation accounts for 21 percent of the nation's economy, 50 percent of its petroleum consumption and 51 percent of ambient air pollution. The number of miles traveled by vehicles worldwide is expected to double by 2020.¹ In the U.S., there are 180 million cars and light trucks on the road, nearly all fueled exclusively by petrol; the American transportation sector relies on petroleum for 97 percent of its needs. The U.S. presently consumes approximately 17 million barrels of oil daily, 11 million of which are devoted to operating vehicles. California alone uses one billion gallons of gasoline per month.

This consumption has serious economic, environmental and social consequences. It contributes significantly to American dependence on foreign oil and hence to the nation's trade deficit.² Automobile fumes contribute more than half the carbon monoxide, one third of the nitrous oxides, one quarter of the hydrocarbons and nearly one third of the carbon dioxide in the air. Refining of oil into auto gasoline has innumerable negative environmental impacts ranging from air and ocean pollution to wildlife mortalities and habitat loss to groundwater contamination.

In California, cars and trucks are the source of 60 to 70 percent of air emissions in areas with the worst air pollution (non-attainment areas).³ The state has the worst air quality in the nation; for example, children in Los Angeles have 15 percent less lung capacity than those living in Houston.⁴

A fundamental change in the American approach to urban design/city planning is the best long-term solution to transportation-related pollution. Jobs, food production, other consumer services and housing must be sited closer together, so that transportation needs overall are reduced. But in the meantime, U.S. oil consumption must be reduced. A shift away from internal combustion vehicles to alternative fuels and mass transit options with fewer environmental, safety and health consequences is required. Ideally, private automobiles and trucks will become secondary transportation options, supplanted by light rail, subways, buses, fast rail and non-motorized modes.

Energy sources other than conventional gasoline can fuel the nation's transportation modes. There is no conclusive answer yet as to which fuel is definitively the most environmentally benign. (There are many alternatives that are less polluting than gasoline, derived from a wide array of natural resources. Appendix 5 at the end of this section provides a summary of these fuels.) Several alternative fuel options offer the benefit of localizing environmental impacts at centralized power- and fuel-generating facilities, while also serving to diversify the energy resources devoted to transportation.

Based on considerations such as environmental impact, cost and availability, plant modifications necessary to begin production, resource base and fuel supply, fuel properties and safety concerns, marketplace realities and existing government policies, we have made the following conclusions:

- Natural gas vehicles are the most promising near-term alternative for use in heavy-duty auto fleets;
- Fuel cells are the most promising auto energy source option in the long term;
- Using a full-cycle emissions⁵ evaluation, cars powered by electric batteries and fuel cells should be the ultimate goal for the passenger car segment of the transportation industry; and
- Of the emerging high speed rail technologies, maglev has somewhat good potential for creating California jobs, if political road-blocks can be overcome.

The alternative fuel auto industry is still immature enough to allow smaller developers and manufacturers to compete with the big three automobile makers—Ford, Chrysler and General Motors—in niche markets. And in California, a policy designating non-combustion engine vehicles/fuels as favorable new industries has already been put in place. As a result, lawmakers, industrialists and researchers in California have set up a public-private partnership called Project California, to create world class competitive industrial clusters in California focused on advanced transportation technologies.

Project California studied the feasibility of six potential investment areas: alternative fuel vehicles; electric vehicles; high speed rail—including maglev (magnetic levitation trains); intelligent vehicle highway systems; mass transit; and telecommunications. Following extensive research on competitiveness, market and infrastructure issues, researchers recommended northern California as well suited to handle the research and development aspects of in-vehicle components and maglev technology, and several other non-transportation industries. The southern part of the state was identified as the most appropriate center for manufacturing.

The Project California team projects that their efforts in realizing an advanced transportation industry in California will generate 200,000 new jobs by the year 2000, and perhaps 400,000 jobs by the year 2010.

Moreover, alternative transportation modes have become a federal priority, with approximately \$692 million earmarked for research and development in President Clinton's fiscal 1995 budget proposal.

But the transition to alternative fuels will not be easy, and may continue through much of the 21st century. The low price of oil, the degree of coordination required between vehicle and fuel manufacturers and refueling infrastructure are three roadblocks to widely accepted alternative fuels.

However, the transition is certain to happen, if government mandates are adhered to. Progressively stricter California vehicle emission standards will be phased in from 1994 to 2003, requiring a change to four vehicle types: transitional low emission vehicles (TLEV), low emission vehicles (LEV), ultra low emission vehicles (ULEV) and zero emission vehicles (ZEV). Straying from continued support (incentives and subsidies) for these standards will result in collapse of the California alternative vehicle industry.

This section of the report focuses on several of the most promising alternative fuels and advanced transportation technologies, including compressed natural gas vehicles, electric vehicles and fast rail.

**Types of
Industry/
Business**

Natural gas vehicles (NGVs)

**Description of
industry/
technology**

Natural gas vehicles (NGVs). The automotive industry grew up on gasoline because it was easier than natural gas to store and transport. That situation has changed dramatically over the past few years, as natural gas is being recognized as a low cost and abundantly available fuel, whose extraction, transport, and distribution infrastructure are well-established.

At present, most compressed natural gas (CNG) vehicles in the U.S. are gasoline cars that have been converted to operate in either a single-fuel (natural gas only) or dual-fuel (either gasoline or natural gas) configuration. Modifications required include changes to fuel delivery and carburetion systems. The cost of converting a standard vehicle to a CNG vehicle is between \$2,000 and \$3,000. Since early 1992, the big three automakers have been manufacturing "dedicated" CNG vehicles, meaning that the vehicle has been designed and manufactured by an original equipment manufacturer to use natural gas exclusively as its vehicle fuel.

These dedicated vehicles are economical; they are approximately 40 percent more efficient than cars with gasoline engines and have about the same efficiency as diesel engines. Moreover, the fuel is cheap; the

national average price for a gallon of CNG is a mere \$0.78, compared with \$0.92 for gasoline and \$1.50 for methanol.

Natural gas is a fossil fuel extracted from underground reservoirs. It is composed primarily of methane, along with other gaseous hydrocarbons such as ethane, propane, butane, and inert gases such as carbon dioxide, nitrogen, and helium. It can also be produced from biomass (burning materials such as garbage at high temperatures) or coal. It is now transported over a vast pipeline network throughout the country and can be easily and safely utilized as a vehicle fuel. Natural gas from a pipeline is compressed and placed in specially designed cylindrical fuel tanks located in the vehicle, through a natural gas fill valve. Natural gas moves from the fuel tanks through stainless steel fuel lines to the engine compartment. There it enters a pressure regulator that reduces the natural gas to atmospheric pressure. Then it mixes with the air intake and flows to the engine's combustion chambers. On a converted vehicle, a fuel selector is mounted on the dashboard which allows the operator to easily select fuel from the natural gas or standard gasoline system instantaneously.

Natural gas has an octane rating of 120 which improves the performance of vehicles. Because it is introduced into the engine as a gas (rather than a liquid that must first be vaporized), compressed natural gas can provide quicker cold starts with lower emissions. In addition, because natural gas is so much cleaner than gasoline, vehicles running on it require less maintenance and fewer oil changes.

Natural gas vehicles are refueled at stations specially designed to deliver CNG or LNG (liquefied natural gas). CNG stations use either the "slow-fill" or "fast-fill" method (see Figure VII-1 for a pictogram of these refueling scenarios for NGVs). Slow-fill stations are simpler in design and less costly than fast-fill stations, but they take several hours to refuel a vehicle in comparison to the two to five minutes associated with fast-fill stations. The slow-fill method involves the use of a compressor which directly compresses the natural gas from the pipeline and dispenses it to the on-board storage tank. It is suitable for CNG vehicles operated by private individuals or by fleet owners who can refuel their vehicles at the end of the work day (as in an overnight filling).⁶

The fast-fill method involves filling the vehicle's on-board storage tank from high pressure bulk storage tanks. The bulk storage tanks are filled from a natural gas pipeline by a compressor.

The fast-fill method takes the same time to refuel a vehicle as conventional filling of a gasoline vehicle (two to five minutes). This method is suitable for a public filling station or a station for fleet vehicles.

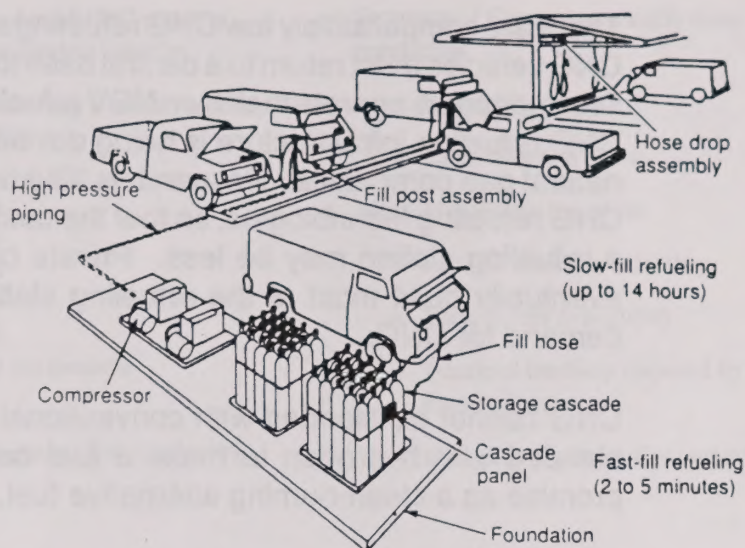


Figure VII-1: Typical CNG vehicle refueling station with fast-fill and slow-fill systems

Presently, most NGVs use compressed rather than liquified gas, mainly because the technology for storing CNG for vehicular use is better developed than for LNG. Due to the extremely low temperature at which LNG must be stored, both the tanks in the ground and in the vehicle must be super-insulated aerospace technology materials to maintain fridity. Furthermore, the liquid gas must be passed through a heat exchanger to return it to gaseous form prior to use in the engine.

The major disadvantage with CNG is the added weight and cost of the natural gas fuel tank. The fuel tank can be large, weighing from 50 to 275 pounds. In the case of dual-fuel vehicles, two separate fuel tanks are needed (one for gasoline, one for CNG), restricting cargo carrying capacity of the vehicle.

Furthermore, the traveling range between refueling of a CNG-fueled vehicle is often less than that of a gasoline- or diesel-fueled vehicle. In order to achieve an equivalent range, the size of the CNG fuel tank must be much larger. Most CNG light-duty vehicles do not have enough tank space to achieve an equivalent traveling range of a gasoline trucks.

These storage and range problems are being addressed, with much of the research focused on cylinder improvements. For example, with the support of the Gas Research Institute, Brunswick Composites has introduced an all-composite, higher-capacity NGV storage tank that is 70 percent lighter than steel, to improve range without increasing vehicular weight. Other innovations include redesigning vehicles to allow economic use of larger tanks.

There are comparatively few CNG refueling stations and therefore many CNG vehicles must return to a central base for refueling. However, most fleet managers operate their own NGV refueling equipment; and a public CNG refueling infrastructure is being developed across the country by natural gas companies. Research is also being conducted to improve CNG refueling technologies, so that the cost of investing and operating a refueling station may be less. Private companies are expected to eventually build most of the refueling stations to meet the non-fleet demand for CNG.

CNG cannot be blended with conventional fuels; it can, however, be blended with hydrogen to make a fuel called hythane, which holds promise as a clean-burning alternative fuel.

Market Potential

Virtually anyone who drives a car, and managers of public and private car fleets are potential customers of NGVs. At present, NGV demand is being driven by federal and state governments. At the federal level, the National Energy Policy Act (NEPACT) of 1992 called for federal fleets in 100 large cities to begin purchasing alternative-fuel vehicles (AFVs) in 1993, and state-operated fleets must begin similar purchases in 1996 (please see Figure VII-2). Also, the Clean Air Act Amendments of 1990 require centrally refueled fleets of ten or more vehicles in 21 ozone-nonattainment cities to begin phasing in LEVs in 1998.

At the state level, California Air Resources Board (CARB) regulations of 1990 mandate sales of reduced emission vehicles in California to improve air quality.⁷ The CARB regulations are the strictest air quality regulations in the country, specifically requiring that by 1998 two percent of all new cars sold in the state be zero-emission vehicles (ZEVs). This percentage will rise to ten percent in 2003 (Figure VII-3). Several other regions and states have followed California's example, or are considering similarly strict mandates (District of Columbia, New England states).

In addition to these "sticks," government carrots promise to create momentum for ZEVs, LEVs and other AFVs. For example, Title XIX of EPACT provides tax incentives for AFVs as well as alternative-fuel dispensing stations beginning June 30, 1993, and ending December 31, 2004. For purchases of alternative-fuel cars and trucks under 10,000 lbs., the law provides for tax deductions of up to \$2,000. Trucks and vans weighing between 10,000 and 26,000 lbs. qualify for up to a \$5,000 deduction, and trucks exceeding 26,000 lbs. may qualify for a deduction of \$50,000. In addition, a \$100,000 deduction may be given to businesses who install natural gas or alternative refueling equipment.

CNG vehicles stand a good chance to capture much of the AFV market, because CNG is among the most cost-effective and environmentally

Discovering Environmentally Sustainable Career Jobs at Closing Military Bases

- National Energy Policy Act of 1992 requires purchases of Alternative Fueled Vehicles
 - Federal fleets (including Executive Order 12844, April 1993)
 - 7,500 in fiscal year 1993
 - 11,250 in 1994
 - 15,000 in 1995
 - 17,500 in 1996
 - 20,000 in 1997
 - 30,000 in 1998
 - 40,000 in 1999 and thereafter
 - State fleets
 - 10% of new purchases in model year 1996
 - 15% in 1997
 - 25% in 1998
 - 50% in 1999
 - 75% in 2000 and thereafter
 - Private and municipal fleets (voluntary)
 - 20% of new purchases in model years 1999, 2000, 2001
 - 30% in 2002
 - 40% in 2003
 - 50% in 2004
 - 60% in 2005
 - 70% in 2006 and thereafter
- Secretary of Energy can modify these regulations
 - Lower percentages
 - Later initiation dates
- Many exemptions based on:
 - Lack of vehicle availability
 - Lack of fuel availability
 - Financial hardship imposed by requirement
 - Garaging of private fleet vehicles

Figure VII-2: Schedule for conversion of fleets to AFVs as required by the National Energy Policy Act of 1992 (Source-"Alternative Fueled Vehicles," Project California Insight, special series, no. 4, July, 1993, p. 5.

CARB Vehicle Emission Regulations*				
YEAR	PERCENTAGE OF TOTAL VEHICLE SALES IN CALIFORNIA			
	TLEV	LEV	ULEV	ZEV
1994	10%			
1995	15%			
1996	20%			
1997		25%	2%	
1998		48%	2%	2%
1999		73%	2%	2%
2000		96%	2%	2%
2001		90%	5%	5%
2002		85%	10%	5%
2003		75%	15%	10%

* ZEVS percentages are required; all others are suggested implementation to meet fleet average emissions reduction requirements.

Figure VII-3: CARB's schedule of increasing the sale of ZEVs starting in 1988 (Source-Same as above, p. 1).

Percent of Revenue by Business, 2000

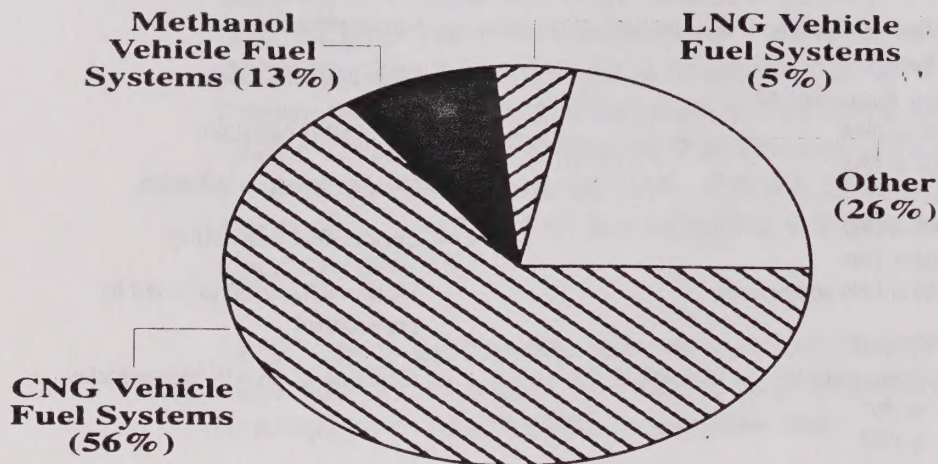
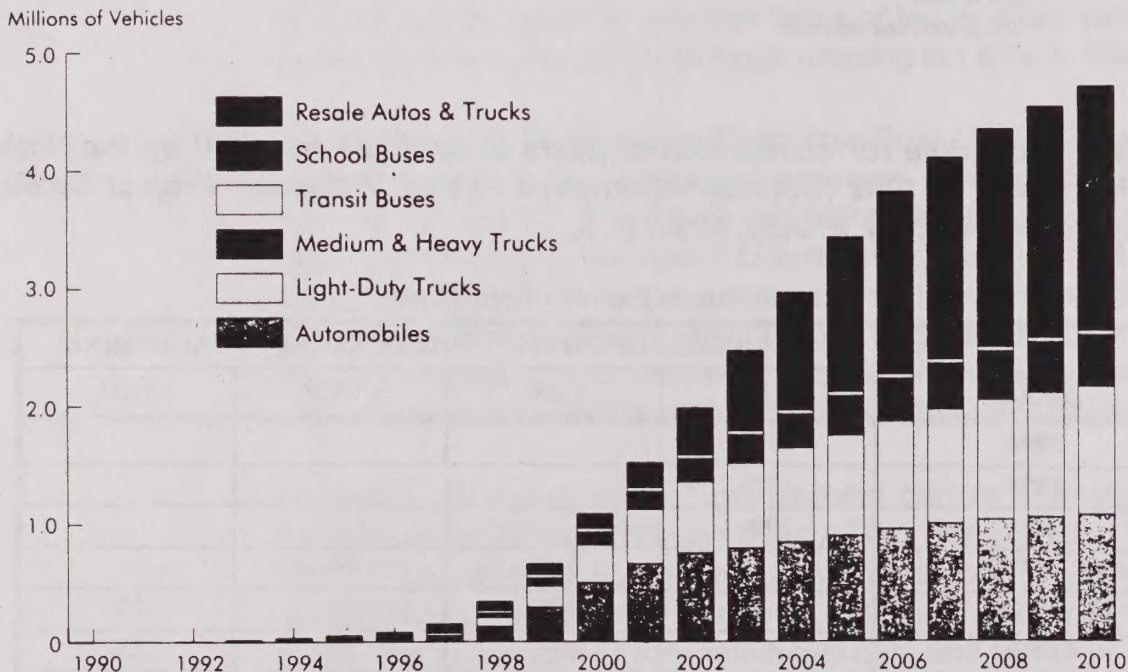


Figure VII-4: Percentage of revenue by type of AFV (Source-Same, p. 5).

NGV STOCK POTENTIAL, REGULATED FLEET & RESALE MARKETS*



*Maximum market potential for all regulated fleet vehicle classes.

Figure VII-5: Maximum market potential for CNG fleet vehicles. (Source-"Natural Gas Vehicles: technology, partnerships move NGVs into the lead," a brochure from the Gas Research Institute.

**National Parks—
Potential Niche
Market for
Alternative Fuel
Vehicles**

The management plans for several jewels of the National Park System call for banning single-passenger cars. Zion National Park (Utah), Yosemite National Park and the Presidio (pending NPS status) all have plans to require mass transit vehicles for their millions of visitors in certain areas of the parks. Significant opportunity exists to market cleaner-fuel buses for use in these and other high-use federal and state parks.

benign transportation fuels that are immediately available. Project California, CARB, and the U.S. Department of Energy estimate that direct manufacturing of CNG vehicle components will command at least 56 percent of the revenue generated by the AFV market in the U.S. by the year 2000 (Figure VII-4), representing a \$150 million business by the year 2003.

The Gas Research Institute projects the maximum market potential for CNG fleet vehicles at over one million cars by 2000, reaching over 4.5 million by 2010 (see Figure VII-5). Stated otherwise, conversion of regulated car fleets alone to natural gas would create sizeable manufacturing and retrofitting opportunities, even without taking the private vehicle market into consideration.

Moreover, taking command of the fleet market would most likely lead to substantial market share in the private auto segment, since fleet conversion would create sufficient infrastructure (refueling and servicing stations) to make driving CNG vehicles attractive to the general public. In conjunction with the cheap price of CNG compared to gasoline and competing alternative fuels, NGVs could become quickly popular.

On the down side, CNG competes with alcohol fuels, such as ethanol and methanol, which can be blended with gasoline in conventional engines and thus provide a convenient transition to alternative fuels. Also, conversion to CNG vehicle use requires new supply strategies (natural-gas transmission companies currently operate separately from oil companies) and modifying refueling stations to accommodate compressors.

**Job creation
potential**

Aggressive marketing by the natural gas industry and the regulatory scenario indicate job growth in NGVs in California in the near term. Natural gas companies, government and equipment manufacturers are working together in regional coalitions in the state to introduce more CNG vehicles into fleets and build a more extensive infrastructure. For example, Pacific Gas & Electric (PG&E) of San Francisco operates a fleet of 640 CNG vehicles and has 45 public and corporate fleet customers to demonstrate the ease of using CNG vehicles. The company has built 32 refueling stations, with plans to build 28 more.

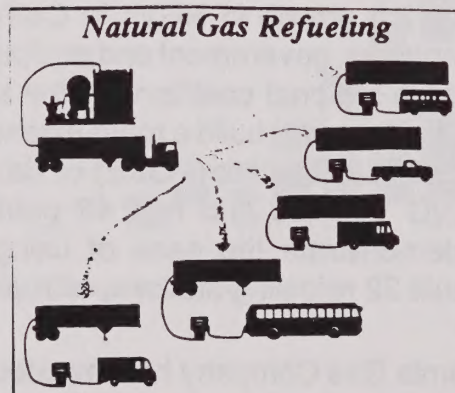
Southern California Gas Company has invested \$32 million to develop refueling stations, coinciding with plans for facilities to retrofit thousands of vehicles per year. They expect to have more than 250,000 CNG vehicles running on Southern California freeways by the year 2000.

Another infrastructure project that built eight refueling stations at pre-existing gas stations in Houston, Texas created 15 jobs, including two service station maintenance technicians, and four technicians for converting and servicing CNG vehicles.⁸

Although Project California's projection of U.S. employment directly related to the manufacturing of CNG vehicles and components seems rather meager, a proper cluster of equipment manufacturers and servicing businesses centralized in one area could generate significant employment.

The assembly of dedicated CNG vehicles will almost certainly take place in Detroit, since the Big Three manufacturers are the primary developers of these vehicles. However, the manufacturing of CNG vehicle components is not strictly limited to that area. Many new developments still need to be made to make the CNG vehicle more competitive with the gasoline vehicle. Former defense contractors may be well suited to conduct the materials research necessary for such innovations.

As an example, Aerojet, a major aerospace/defense contractor headquartered in Sacramento, has recently joined with PG&E to develop, certify and demonstrate a mobile natural gas storage tank that can be used to supply natural gas fuel to companies operating NGV fleets (Figure VII-6). Aerojet projects that 200 jobs could be generated when the modules go into production in two to three years. As many as 2,000 new jobs could be created (or saved, due to conversion of workers from military to civilian work) by the year 2,000 when there will be a greater demand for NGVs. PG&E says that 100 jobs had already been saved by the project, which is still in the developmental stage.



After refueling at a large centrally located compressor station, a "module" of 20 interconnected tanks can be transported on a truck bed to any location and left at a site to fuel natural gas vehicles. Replenished mobile storage modules would replace empty units, which would be transported back to the main station to be refilled, eliminating the need to build as many permanent fueling stations.

Figure VII-6

**Environmental,
Health & Safety
Issues**

Natural gas is a fossil fuel, and therefore not a permanent preferred solution to the nation's transportation energy needs. The main reason for advocating interim adoption of natural gas as a fuel source is that it is primarily a domestic resource, as opposed to gasoline, made mostly from imported oil. Natural gas therefore eliminates the high environmental costs of drilling, piping and shipping oil over extremely long distances.

NGVs provide multiple other environmental advantages over gasoline-powered cars. They not only contribute a lot less to local smog than do gasoline vehicles; they also emit 25 percent less carbon dioxide, a chief contributor to global warming, and 50 to 80 percent less hydrocarbon emissions overall. Emissions reductions from NGVs can be dramatic; Southern California Gas Company (SoCal) estimates that the utility company's first 130 NGVs will result in a reduction of nine tons of air pollutants in a year.⁹

Although CNG vehicles have traditionally emitted high levels of nitrogen oxides, newer, dedicated CNG vehicle engines have been designed to emit less. The engine of Chrysler's full-size NGV Dodge Ram van has been hailed by gas utilities across the country as the cleanest van engine ever produced, and is the first auto-industry NGV to be certified in California. In low-mileage tests, the van emitted less than 5 percent of the nitrogen oxides allowed for low-emission vehicles (LEVs) and just over 8 percent of the allowable ultra-low-emission vehicle (ULEV) nitrogen oxide standard for 1998. Ford's NGV Crown Victoria could also meet California's ULEV standard as well.

Compared to gasoline and competing alternative fuels, such as methanol, natural gas is a safer fuel for use in vehicles. It is non-toxic and non-carcinogenic. Also, because the density of CNG is less than that of air, it dissipates quickly instead of accumulating on the ground in pools like gasoline or other liquid fuels, reducing threats to land or water from spillage. Moreover, there are no evaporative emissions when natural gas is in use in a running car; in contrast, many of the emissions from gasoline occur when a car is sitting idle. There are also advantages over alcohol fuels; ethanol, for example, is land- and water-intensive (from growing corn, the source of the fuel) and can contribute to soil depletion.

Natural gas storage cylinders have been shown to be safe. They are designed and constructed to rigid safety requirements for thermal cycling, fatigue, fire immersion and burst pressure. The physical properties (high ignition temperature, which is 600°F higher than that of gasoline, and quick dissipation due to density) of natural gas reduce the chance of its ignition in an accident, as compared to gasoline.

However, natural gas is a nonrenewable resource (except for gas obtained from landfills). Any long-term demand would have to be filled by drilling in "inferred reserves" (reserves known to exist but untapped), some of which are in environmentally sensitive areas. And one economic scenario predicts widespread conversion to NGVs could lead to increased energy demand overall, because of natural gas' relative cheapness to the consumer. (Another suggests the price of natural gas will go up substantially with any significant increase in demand.)

Further research is needed to determine potential environmental impacts of manufacturing specific types of CNG vehicle components. Also, the environmental impacts of design/construction of refueling stations will need to be carefully considered.

Infrastructure requirements

In general, Project California tends to view northern California more as a research and development than manufacturing center for the budding advanced transportation industry. For R&D activities, the most likely northern California venue is Silicon Valley, which offers existing facilities and a large labor pool experienced in high technology.

However, Fleetstar Inc. of Sacramento will be establishing an assembly site in California in 1994 to build refueling stations. The new assembly site will hire 15 to 20 employees, primarily technicians. And a cluster of businesses focused on non-manufacturing activities related to CNG vehicles could also be feasible for the Bay Area. A facility to retrofit cars, a training center for mechanics, repair shops for CNG cars and a training center for workers specializing in designing/constructing CNG filling stations are potential opportunities. (See the "Swords into Cars" sidebar on this section for potential funding sources for some of these opportunities.)

Companies, Agencies and Associated Organizations

Aerojet, 1940 Alabama Ave., Rancho Cordova, CA 95741-3530
Contact: Linda Means, (916) 351-8500

California Air Resources Board, 1102 Q Street, Sacramento, CA 95814, (916) 575-6970
Contact: alternative fuels department

Enfuels Corp., Houston, TX. Contact: Anne-Marie Nimer, (713) 696-6800

Fleetstar Inc., 1010 Hurley Way #300, Sacramento, CA 95825. Contact: Jason McMillan, (916) 641-5999

Gas Research Institute, 8600 West Bryn Mawr Ave., Chicago, IL 60631. Contact: Virginia A. Hobbs-Moore, (312) 399-8176

Pacific Gas & Electric, 77 Beale Street, San Francisco, CA 94177
Contact: Brian Peppers, (415) 973-7000

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Project California, 100 Academy Drive, Irvine, CA 92715. Contact: Donald Shields, (714) 854-4150

Southern California Gas Company, 555 W. 5th Street, Los Angeles, CA 90013 - 1011

Interviews & Sources

(All the contact people listed above, except Donald Shields)

National Alternative Fuels Hotline (for transportation technologies); Barbara Sigler

Project California: Pam Leeper

"Alternative Fueled Vehicles," Project California Insight, special series, No. 4, July, 1993

"Use of CNG as auto fuel proliferating" *Oil and Gas Journal*, Oct. 5, 1992

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"Natural Gas Vehicles: technology, partnerships move NGVs into the lead," a brochure from the Gas Research Institute

"Alternate Fuel Use in MSW Operations," *MSW Management*, May/June 1993

"Driving out oil dependency...the push to develop clean cars," *CQ Researcher* v2, no. 25 (July 10, 1992): p.584

"When it comes to natural gas vehicles, we've got all the answers," a technical information flyer from Wisconsin Gas

"Compressed Natural Gas as a Transportation Fuel," a technical information flyer from the State of West Virginia Governor's Office of Community and Industrial Development fuel and Energy Office and West Virginia University

"Aerojet Invests Technology into Clean-Air transportation" CALSTART Connection Newsletter, Aug/Sep 1993, Vol.1, issue 2

Types of Industry/ Business

Electric vehicles (EVs)

- Battery-powered
- Flywheel-powered
- Fuel cell-powered
- Solar-powered

EV recharging stations

Description of industry/ technology

Electric vehicles. Currently, only the electric car can meet California's requirement for sales of zero-emission vehicles (ZEVs) by 1998. ZEVs represent a huge export market opportunity, as other states follow

California in adopting ZEV provisions, assuming California political leaders resist pressure by conventional fuel auto manufacturers to roll back these provisions.

The electric vehicle (EV) is powered by electric batteries rather than an internal combustion engine. Electricity for electric vehicles can come from all of the renewable energy sources, as well as from fossil fuels and nuclear power.

Electricity-powered cars can result in far lower net air emissions if the power is generated from nonfossil resources. (If coal, for example, were used to produce it, both greenhouse and other emissions would rise.) Because the motor draws power directly from the battery, there are no direct emissions, eliminating the need for cumbersome automotive tailpipe/emission control technology. Moreover, electric vehicles are efficient and quiet. The supply infrastructure (electric grid, linked to most U.S. homes) is already in place.

Electric cars would have the most beneficial impact on smog and energy consumption of all the existing alternative fuels. Even after accounting for the pollutants produced by power plants (which provide electricity to charge car batteries), electric cars release 98 percent less carbon dioxide than conventional cars. In addition, there are no escaped emissions from pumping of gas at service stations.

But there are significant barriers to overcome. Because of weight restrictions and the different power source, over 70 percent of the components in an EV must appreciably modified from their gasoline counterparts. Several other obstacles stand in the way of commercially successful electric vehicles:

- High purchase price. EVs presently cost 20 to 40 percent more than an equivalent gas car (about \$40,000), depending on the type of batteries. Conventional batteries must be replaced every two to three years, at a cost of approximately \$1500. However, these costs are partially offset by the corresponding reduced maintenance and fuel costs. It costs \$2.32 to power an electric passenger car for 240 miles, compared to \$14 for a gasoline counterpart.
- Lack of power and short range. General Motors Corp. has an electric car, the *Impact*, being readied for full production sometime in the mid-1990s. Although it can accelerate from zero to 60 mph in eight seconds, its maximum cruising speed is 70 mph, with a total range of 120 miles on one battery charge.

■ Long recharging time.

The range, acceleration, and top speed of electric vehicles depend on several factors: electric motor performance; vehicle weight; friction between tires and road surface; and above all, battery performance. An electric car battery must store large amounts of energy, draw that energy at fairly high rates, be charged and discharged several hundred times, retain the charge over extended periods of time, and charge/discharge over a wide range of temperatures.

Two parameters are important in the discussion of batteries: specific power and specific energy. Specific power is the amount of power generated by the battery and is expressed as watts/kilogram (w/kg). Specific energy is the capacity, or the amount of power the battery stores at a specific rate of discharge and is expressed as watt-hour/kilogram (w-hr/kg). Great specific power is needed for strong vehicle performance, as in acceleration. As specific power increases, the specific energy drops. The distance a vehicle can travel, however, is proportional to the specific energy.

Thus, the current electric car suffers from awkward trade-offs between acceleration and range. The solution to developing an ideal electric car is in designing a battery to optimally balance the specific power and energy. Current electric car batteries used include lead-acid and nickel-cadmium; the most advanced model is the Horizon battery developed by the Electric Power Research Institute (EPRI) and Electrosources Inc.. It has the specific power approximately equal to the goal set for midterm batteries, but 40 percent less specific energy.⁹ However, the limited charges of these lead batteries restrict widespread applications. Furthermore, the life of these batteries can be reduced when they are fully discharged: hence, they must usually be recharged after 80 percent of the energy is used.

The U.S. Advanced Battery Consortium (USABC), a government and business alliance that includes the Big Three automakers, has set the following goals of specific power and energy for their midterm and longterm batteries:

	<u>specific power</u>	<u>specific energy</u>
<u>midterm</u>	150-200 w/kg	80 w-hr/kg
<u>longterm</u>	400 w/kg	200 w-hr/kg

Midterm batteries are those whose prototype production tests are complete by 1994. Longterm batteries are those whose design will be verified to work by 1994 and ready to be produced by 1997.

Midterm batteries include nickel-metal-hydride (NiMH), nickel-iron, zinc-bromide, sodium-sulfur, and lithium-iron monosulfide, with the **NiMH the sole truly promising technology**.¹⁰ The NiMH battery is being developed under an \$18.5 million contract with USABC and Ovonic Battery Co. in Michigan. It is being touted by its developers as the "new, non-toxic, environmentally green electric car battery that requires no maintenance."

The NiMH battery satisfies almost all the requirements USABC has set for midterm batteries. It doubles the range of lead-acid batteries in current use, allowing a passenger car to run for 250 to 300 miles on one charge. It can be charged more quickly (in less than one hour) and lasts longer (ten years, as opposed to three to five years). However, it costs \$200 per kw-hr of energy generated, more than the cost of lead-acid batteries, and more than the USABC midterm battery goal. It also falls short of USABC's goal for specific energy, producing only 80 w-hr/ kg., although the developers feel it could have the potential to produce 150 w-hr/ kg.

Long-term batteries include **lithium-polymer, the flywheel battery and the fuel cell**. The **lithium-polymer battery** uses flexible solid-polymer electrolytes. It has no corrosive reactions, does not need to vent gases from its battery pack, requires no rugged sealing, is recyclable, and operates at ambient temperature. It should be able to meet both criteria set by USABC.

The **flywheel** operates on the principal that revolving wheels store mechanical energy by using their own mass to propel themselves once put in motion. It has the potential to power electric cars for a longer range on a single charge than gasoline cars. Its development is being rigorously pursued by several public and private research institutions.

The primary challenge of flywheel battery development has been to find a material that could withstand high revolving speeds, and be light enough to be carried in a car. American Flywheel Systems is building a prototype made of a graphite fiber composite. Its flywheel is capable of spinning at speeds of 200,000 revolutions per minute without coming apart. The flywheel would float in a vacuum upon sets of magnetic bearings that could allow them to spin for months. Ten batteries would fit in a box smaller and lighter than that for lead-acid batteries presently used in cars.

AFS estimates the range of such a battery pack at 300 to 600 miles on a single charge. The theoretical flywheel car would be able to accelerate from zero to 60 mph in eight seconds flat (these projections are based only on computer simulations). EPRI cites several problems with the flywheel battery. While providing long driving range, it lacks sufficient acceleration power for passing cars and climbing hills. Furthermore, the fast revolving wheels could be deadly trajectories in an accident. Finally, the cost of composite materials puts flywheels even further out of reach as a feasible mass-production option.

Project California heralds the **fuel cell** as the ultimate power source for electric cars. (Please see a full description of fuel cell technology in the Alternative Energy section.) Unlike batteries (which produce and store kinetic and heat energy) or flywheels (produce and store mechanical energy, which can be transformed to electricity through combustion) the fuel cell produces electricity directly, by chemically combining hydrogen and oxygen to form water. This direct energy conversion means highly efficient generation (twice as efficient as a standard internal-combustion engine).

Because they can use any source containing hydrogen (including methanol, biomass or natural gas), fuel cells could foster a healthy diversity in the transportation fuel sector. Current fuel cells operate on a methane based fuel, such as natural gas or methanol, while future fuel cells might work on pure hydrogen, essentially emission-free.

Moreover, because they eliminate the combustion engine, fuel cells have low maintenance costs and would result in longer vehicle life. However, current-generation fuel cells are too heavy and expensive for widespread applications. Further development will be necessary before they can be used in heavy vehicles and in electric cars. They have strong promise to give EVs a range comparable to or greater than a standard gasoline vehicle.

Another lingering concern is that the fuel cell, like the flywheel battery, would be lacking in adequate power. Project California surmises that "most fuel cell vehicles are likely to be hybrid vehicles, since the variation in energy consumption for a moving vehicle is more easily met with a stored energy from a battery."¹²

Approximately 500,000 jobs are expected to be created by 2020 in electric cars.¹³ ZEVs are net-beneficial vis a vis air emissions only over the long haul, as compared with ultra light-emission vehicles and LEVs. But in the long term, the degradation of engines in LEVs results in greater overall emissions than from ZEVs. And ZEVs are 90 percent cleaner

than conventional combustion engine cars given life-cycle considerations.¹⁴ Hydrogen power fuel cells may be the eventual best technology for powering cars.¹⁵

Solar powered vehicles derive their energy from solar cells mounted on their roofs. Solar energy, especially solar cars, could dramatically reduce the social and environmental costs of transportation. Solar cars utilize a renewable energy source, eliminate greenhouse-gas or other emissions, are noise-free and can be 100 percent recyclable.

The drawbacks are: large storage cell capacity; first-generation technology, with low-efficiency design; and prohibitive cost. For these reasons, solar-powered cars are a long-term goal, and hold the most promise for those regions where sunlight is abundant. (For a full discussion of the benefits, limitations and technology of solar energy generation, please see the Alternative Energy section.)

Electric car recharging stations. Part of the formula to make electric vehicles more competitive with gasoline vehicles is a practical, convenient battery recharging infrastructure. The Infrastructure Working Council, a committee composed of representatives from the auto, electric utility and power charging equipment industries, is coordinating efforts to develop an electric vehicle support infrastructure.

Four types of charging facilities (Figure VII-7) are envisioned. Slow recharging, which would take anywhere from a few hours to overnight, would take place either at home, in parking lots, or at curbside meters. Technology for these structures is already available for widespread application. Fast recharging, which would allow a quick boost of energy in five to ten minutes, would take place at the equivalent of gas filling stations. The equipment necessary for this type of facility is still under development.

Market Potential

California air regulations have set a worldwide trend in the requirement of sales of low-emission and zero-emission vehicles, and development of an alternative fuels infrastructure. With this lead, the state will be the single largest market for EVs in the world well into the 21st century. New York and Massachusetts have already adopted similar regulations, with 19 other states considering following suit. Japan and Europe may take similar measures.

In California alone, CARB regulations will require the sale of about 40,000 EVs. This number will increase to 200,000 by the year 2003.

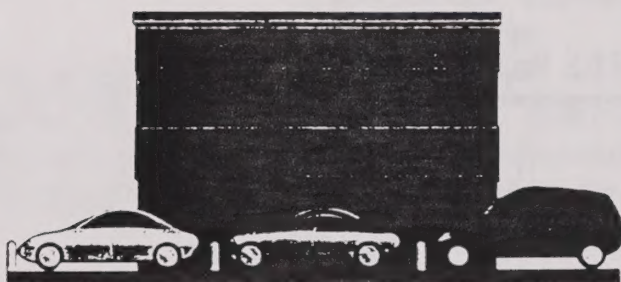
Discovering Environmentally Sustainable Career Jobs at Closing Military Bases



HOME/OVERNIGHT EV developers and electric utilities expect most vehicle charging to take place overnight at homes or businesses during off-peak periods of demand for electricity, partly in response to incentive utility rates that will reflect the lower cost of off-peak generation. Devices from simple clock timers to smart chargers that communicate with the utility system may be used for home charging as production EVs enter the consumer market.



PARKING LOT Specially marked spaces in public parking lots and garages (such as at malls) will help extend the range and convenience of EVs for short trips and errands. Charging spaces in company-owned employee parking lots will encourage EV commuting. Dedicated charging spaces at public transit facilities are already being demonstrated.



CURBSIDE Some utilities are providing limited numbers of public-access (in some cases, free) curbside charging connections to support early demonstration vehicles. But as the number of EVs in use grows, coin- or credit-card-operated parking-meter-type connections could again become common, as they were in cities such as Chicago and Detroit early in this century.



FAST CHARGING Systems featuring off-board, high-power electronics are under development that could provide the electric equivalent of a filling station. There, in 10 minutes, or about the time it takes to refuel a conventional vehicle, an EV could receive a booster charge that might add 70 to 100 miles of driving range. In order to minimize increases in peak period demand, researchers are exploring the possibilities for fitting these facilities with energy storage devices (such as flywheels, batteries, and superconducting magnetic coils), which could be charged at night for serving EV users throughout the day.

Figure VII-7: Key types of EV charging facilities (Source- "Battery Charging for Electric Vehicles," EPRI Journal, June 1993, p.1)

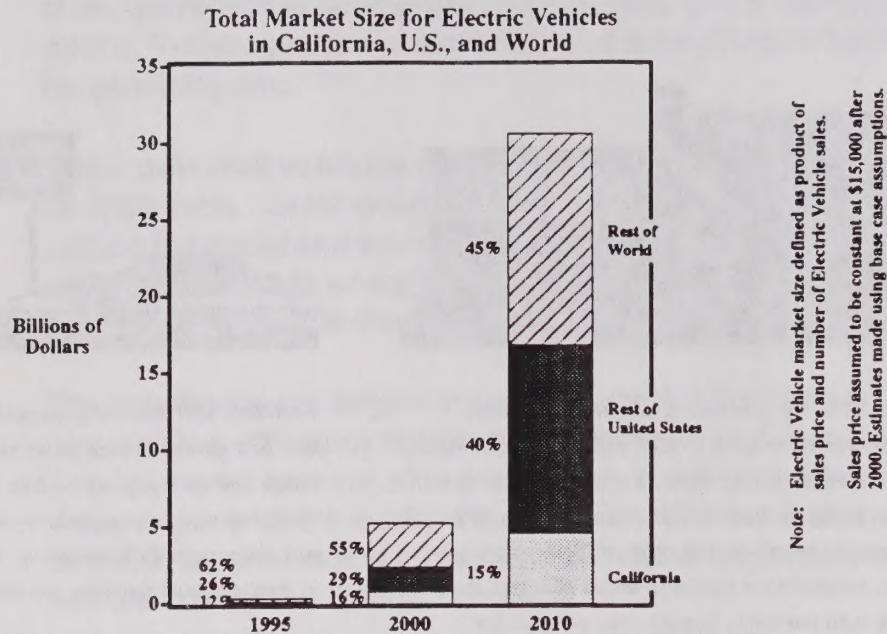


Figure VII-8: Total market size for electric vehicles in CA, U.S., and world, expressed in terms of revenue per year (Source-"electric Vehicles," Project California Update, Vol. 2, no. 1, Feb. 1993, p. 4).

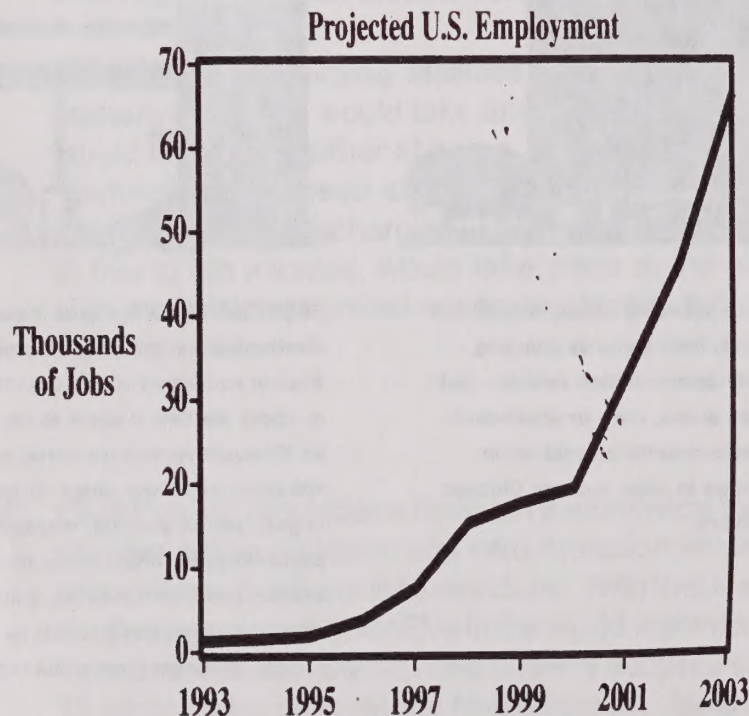


Figure VII-9: Projected # of U.S. jobs of all functions to be created by the direct manufacturing of EVs and components (Source-"Electric Vehicles," Project California Insight, Special Series, No. 2, June, 1993, p. 4).

Project California estimates the worldwide demand for EVs will top 800,000 vehicles per year by the year 2000, a \$6 billion annual market (assuming the average price for one car is \$15,000). (Please see Figure VII-8.) By the year 2010, the market will boom to nearly two million cars, or more than \$30 billion, as the electric vehicle matures to a stage where it would sell by virtue of its quality rather than by regulations.

But barriers to successful commercialization of EV technology are myriad, including inadequate financing, high cost of doing business and marketing difficulties. One market condition is certain: any political attempts to roll back EV mandates will have a certain, devastating effect on the fledgling alternative fuel car industry. The electric car market is currently heavily dependent on state and federal subsidies, and thereby subject to the vagaries of economic/budgetary/political processes. For example, Calstart, a Burbank-based private/public consortium working on electric cars, received only \$3.4 million of the \$42.4 million in federal defense industry conversion grants it requested for 21 projects.¹⁶

Moreover, battery technologies are young and per unit costs very high.¹⁷ Prices and lifecycle costs for electric vehicles will drop significantly as production increases. Finally, the competition to attract advanced transportation businesses is thick, with southern California currently having the edge.

From Swords into Cars: EV Government Funding Sources

Various state and federal agencies are united in keeping the burgeoning advanced transportation industry centered in California, and have struck up innovative partnerships to that end. For example, the Sacramento Municipal Utility District and the U.S. Department of Defense recently awarded a \$2 million grant for the development of an advanced flywheel, part of the agencies' total \$5 million in federal funds for development of electric vehicles. A prototype flywheel for powering cars is expected to be introduced in 1996.

Nevertheless, given the size of the potential EV market, northern California should expect to get a share. Attempts to site EV companies should probably begin with small manufacturers such as U.S. Electricar, and with state agencies such as Project California and CALSTART.

CALSTART is a public/private partnership to foster advanced transportation technologies, by redirecting defense-related facilities and workers. With money provided by private industry, and state and federal sources, CALSTART funds transportation projects that create jobs, improve air quality and have reasonable near-term commercial potential. Total proposed funding of \$127 million is being directed to such projects as prototype EV cars and buses, EV charging stations, CNG engines for marine vessels, intelligent highway systems, training (including EV assembly and maintenance), battery and fuel cell technologies, and others.

For example, CALSTART, Cal/EPA, Southern California Edison and other partners have provided nearly \$9 million for a two-year program to develop a vehicular hydrogen-powered fuel cell and electrochemical engine.

In addition, CALSTART has a venture capital committee that works closely with member firms to locate seed capital and provide advice. Other services include marketing, legal, strategic partnering and networking.

Job Creation Potential

Given the enormous projected demand for electric vehicles, the job potential for this industry is equally tremendous. California's strengths in engineering, high-tech research and production, entrepreneurial activity, world class universities, and advanced aeronautics and electronics should allow California to capture many of the jobs created by the EV industry. Project California estimates that by 2003, about 70,000 new jobs (including direct manufacturing and assembly, and indirect construction, deployment and service jobs) can be created by EV-related businesses (see Figures VII-9 & 10).

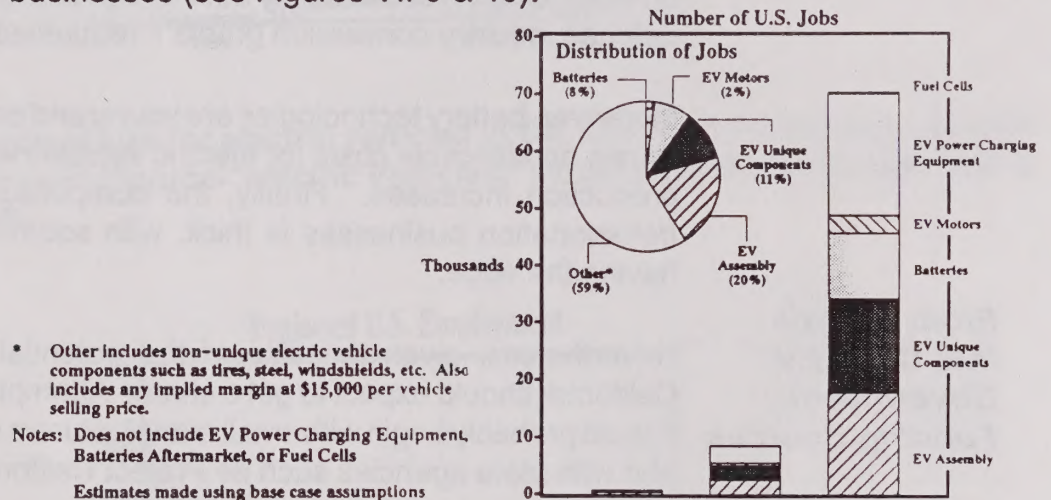


Figure VII-10: Distribution of the projected number of jobs into the different EV sectors (Source- Same as VII-8).

Project California concludes that California is highly likely to capture as much as 40 percent of the U.S. market share by the year 2000. Nevertheless, California is less likely to be successful in attracting EV motor or EV assembly manufacturers, because of the perception that California manufacturing involves higher costs and greater bureaucracy than other states, according to Project California.

Significant job opportunities will exist in the construction and operation of recharging stations. A variety of white collar and blue collar jobs will be created by the EV industry, from assembly workers to mechanics to electrical engineers to sales and support staff. The assembly jobs will only require technical training, while the engineering jobs will require more advanced education.

**Environmental,
Health & Safety
Issues**

Electricity used to charge EV batteries sometimes uses a nonrenewable resource (fossil fuels). Since fuel cells, flywheels, solar panels and electric batteries generate electricity on board, the vehicles they power produce virtually no air emissions. Compared to gasoline power, these energy production methods result in lower lifecycle greenhouse-gas, nitrogen oxides, hydrocarbon, carbon monoxide and particulate emissions.

The manufacture and disposal of batteries containing lead and other heavy metals (such as cadmium and lithium) cause water and soil pollution, and present worker safety concerns. Workers in the manufacturing of batteries are consistently among those adults with the highest lead content in the blood, according to the results of a statewide surveillance program based on medical laboratory reports since 1987. Elevated blood lead levels carry can result in lead poisoning and serious health consequences.

Lead acid batteries may be hazardously caustic. Cadmium and lithium are quite toxic. The disposal of these batteries also poses an environmental problem. According to the EPA, 80 percent of car batteries are recycled and most of the pollution problems associated with batteries comes from household batteries. However, those car batteries that are not recycled leach toxic heavy metals and lead into the soil and eventually into groundwater.

Fortunately, the nickel metal hydride battery is free from these environmental and worker safety concerns, because it contains no toxic or caustic chemicals. The flywheel battery and fuel cell are also environmentally sound for the same reasons. However, it is uncertain if the manufacture of their casings will pose any threat.

**Infrastructure
requirements**

While southern California is better positioned to capture EV assembly opportunities, there may be some northern California manufacturing and support prospects. Local governments could make a commitment to either buy a small number of electric vehicles or to retrofit fleet vehicles, to attract a budding EV manufacturer to the site.¹⁷

Smaller, entrepreneurial EV manufacturers represent the most likely target for job development at Bay Area converting bases, since they are less deterred by the risk involved in delving into such a young industry at a new site. Siting an EV manufacturer could also be the first step in attracting EV battery manufacturers.

**Companies,
Agencies and
Associated
Organizations**

American Flywheel Systems, Seattle, Washington, (206) 454-1818

Amerigon (CA), (818) 565-5500. Electric car research firm

BAT International, 2471 South 2570 West, West Valley, UT 84119, (801) 977-0119. Research and development proprietary technology for electric car industry.

California Electric Cars

CALSTART: Paul Helliker, Principal Engineer, 3601 Empire Avenue, Burbank, California 91505, 818-565-5600

Conceptor (Ontario)

Cushman (NB), 900 N. 21st St., Lincoln, NE 68501, (800) 228-4444

ELCA Battery Co., 2487 Spring St., Redwood City, CA 94063. Contact: E. Boxer, manager of public relations, (415) 369-2699. Research in EV batteries, fuel cells, electrochemical processes

Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, CA 94303. Contact: Barbara Klein, manager of public information, (415) 855-2000

Electric Vehicles of America (Massachusetts)

Electric Vehicles Corp., Van Nuys, CA. Contact: Chaz Haba, (818) 909-3501. Converts combustion vehicles to electric

Green Motorworks, North Hollywood, CA. Contact: Bill Meurer, (818) 766-3800. First electric vehicle dealership in U.S.; electric car service facility

Infrastructure Working Council

Project California, 100 Academy Drive, Irvine, CA 92715. Contact: Donald Shields, (714) 854-4150

Recovery and Reclamations Inc., Pecos, TX

Sebring Auto-Cycle, 424 Hairpin Dr., Sebring Airport, Sebring FL 33870, (813) 655-2131

Solar Car Corp., 1300 Lake Washington Rd., Melbourne, FL 32935 (407) 254-2997

U.S. Electricar: Terry Price, Sebastopol, CA (707) 829-4545. Largest producer of electric cars in North America

Solar Components Corp., 88 Pine St., Manchester, NH 03105 (603) 668-8186

Taylor-Dunn Manufacturing Co., P.O. Box 4240, Anaheim, CA 92803-4240

**Interviews &
Sources**

Project California: Pam Leeper

Energy, Manufacturing and Transportation Technologies Program, Lawrence Livermore National Laboratory. Contact: Anthony Chargin

EPRI: an engineer who did not want to be quoted & therefore did not identify himself

"Electric Vehicles," Project California Insight, Special Series, No.2, June, 1993

"California Can't Wait" CALSTART Connection Newsletter, Vol.1, issue 2, Aug/Sep 1993, p.1

"CALSTART responds to EV critics," CALSTART Connection Newsletter, Vol.1, issue 2, Aug/Sep 1993, P.7

"Off and Humming," *Time*, v141, n17 (April 26,1993): p.53

"New battery for electric cars," *USA Today* (magazine), v122, n2579 (Aug., 1993): p.13

"Energizing the batteries for electric cars," *Mechanical Engineering-CIME* v115, n7 (Jul., 1993): p.73

"Plotting revolutions in electricity storage," *Technology Review*, v95, n8 (Nov-Dec, 1992): p.19

"Battery Charging for Electric Vehicles," *EPRI Journal*, June, 1993: p.6

"Electric Vehicles," Project California Update, Vol.2, n.1 (Feb, 1993): p.4

**Types of
Industry/
Business**

Fast Rail

- High speed rail (HSR)
- Magnetic levitation trains (maglev)

**Description of
industry/
technology**

No discussion of improving air quality and reducing U.S. oil dependency would be complete without a consideration of high speed rail (HSR). Fast rail is envisioned by its proponents as a cost-effective means of relieving the air and road traffic pressure between closely located metropolises; for example, between Los Angeles and Las Vegas or Pittsburg to Chicago. Widespread deployment of HSR would attack problems attendant to the U.S. oil-based transportation system, in addition to road and airway congestion: high subsidies for highway construction/ maintenance/services; accidents; freeway noise; and the destruction of large areas of open space for freeway and airport construction. The recent Los Angeles earthquake demonstrates more than words the great mistake in nearly singular dependence on freeways for commuting long distances.

Fast rail consists of two types of technology: steel wheels on steel rail and magnetic levitation. The first, often referred to as **high speed rail** (HSR), is already technologically feasible. It is a technologically-

advanced version of standard train technology, but built to tight tolerances, high strength and speed rather than cargo criteria.

HSR has already been successfully deployed in Europe and Japan. Amtrak is presently testing the German ICE train and the Swedish X2000 for deployment in its Northeast Corridor line (Washington, D.C.-New York City-Boston). Of these two European HSR trains, the X2000 seems the most adaptable to American use. Unlike the German ICE train and other HSR trains, which require long stretches of straight tracks for optimal operation, the X2000's special tilting technology allows it to handle curved tracks (prevalent in the U.S.) much more efficiently, without compromising performance.¹⁹

The relatively low price of implementing the Swedish technology also makes it attractive. According to ABB Traction, the American subsidiary of the Swedish company that makes the train, the cost of a rail project using the X2000 is usually lower since existing rail systems can be used. (Dedicated tracks require not only the laying of track, but the purchase of large belts of land and right of way for the straight tracks.)

Magnetic levitation (maglev) is an entirely different technology from conventional trains. Superconducting magnets lining the track and the undercarriage of the train lift the train off the track. Magnetic or other modes of propulsion then propel the train on its thin cushion of air. Since rolling and surface friction are eliminated, magnetic trains can reach speeds above 300 mph. Comfort and silence are also greatly improved.

Germany and Japan already have prototype maglev train systems. But there are significant barriers to their practical use: the cost and operation of superconducting magnets; the potential danger of the high-energy electromagnetic field generated by the magnets; and the complex levitation control system.

Market Potential

The picture for maglev is muddled. As part of a \$151 billion transportation bill approved by the U.S. Congress in 1991, \$725 million was set aside for the development of a prototype maglev vehicle, expanding the National Maglev Initiative, a partnership of the Departments of Energy and Transportation and the Army Corps of Engineers.

But vigorous lobbying by the Michigan Congressional delegation against releasing this funding appears to have shelved immediate federally-sponsored plans. Strong White House and other Congressional support will be necessary to push this effort forward.

If political hurdles are overcome, seven inter-city routes are scheduled to come on line between 1999 and 2008 in the U.S. (Figure VII-11). Whether they will utilize steel-on-steel technology or maglev is yet to be determined.

Even if only four of the city-to-city projects are completed by 2010, the U.S. market for fast rail will be \$2 billion (Figure VII-12). The nationwide fast rail market would continue to rise to \$2 billion annually by the year 2010. Worldwide, the demand will be about \$7 billion annually.

If federal initiatives proceed, the market in California is likely to peak around the year 2000, with the deployment of fast rail on the San Diego-Los Angeles-San Francisco route in the early 21st century. (Planning for this line is in the earliest stages.) If this route is built, it will represent over \$400 million, or 40 percent of the total U.S. demand for high speed railcars.

Competition for siting maglev manufacturing will be fierce. New York is competing to localize fast rail manufacturing for the northeast. That region is in a stronger position, given its prevalence of rail transportation as compared to California. However, Bechtel Corp. of San Francisco is one of four development teams in the country to submit concept designs to the National Maglev Initiative; these prototypes are to be demonstrated in 1999, contingent on the release of federal funds.

And California would be likely to attract some rail component manufacturers, especially the more high-tech electronic components known as C3: command, control and communications technology for high-tech transportation.

Moreover, a tactic which has succeeded already is to require that any manufacturers of fast-rail train systems being installed in California conduct some or all of the assembly of the trains and components in the state. Unfortunately, the long-term viability of such an assembly facility would be uncertain beyond the initial project.

Job Potential

The total number of U.S. direct manufacturing jobs to be created by fast rail is rather small; barely 6,000 jobs by the year 2010 (Fig. VII-13). Over half of these jobs will be in the indirect sector of C3, a technology which is probably most appropriate for development in Silicon Valley. About 1,500 manufacturing jobs will be created in rail vehicle assembly and components manufacturing.

Scenarios

Conservative	DAL-HOU completed 2003 LA-SD completed 2007
Base Case	DAL-HOU completed 2001 LA-SD completed 2004 LA-SF completed 2006 NE Corridor upgrade completed 2009
Aggressive	DAL-HOU completed 1999 DAL-SAN completed 2000 LA-SD completed 2000 LA-SF completed 2003 NE Corridor upgrade completed 2006 CHI-MIL completed 2008 LA-LV under construction 2007

Figure VII-11: Projected U.S. Fast Rail Capital Expenditures through 2010 based on three different deployment scenarios (Source- "Mass transit and fast rail," Project California Insight, special series, no. 5, July, 1993, p. 5).

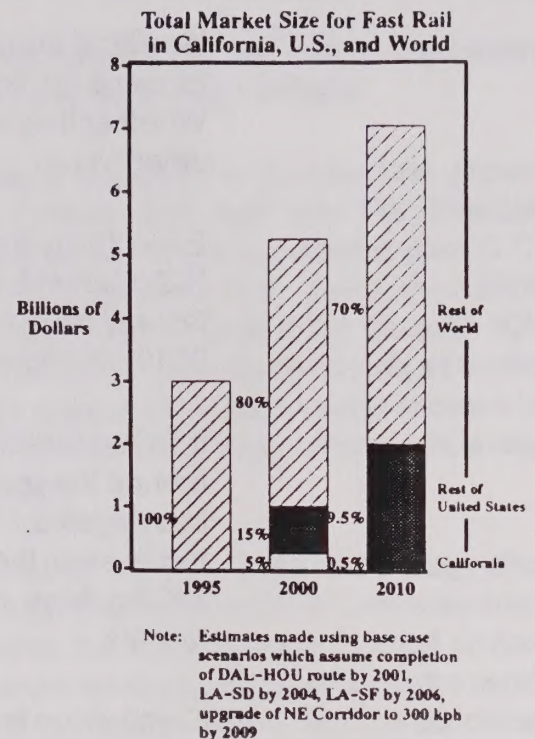


Figure VII-12: Total market size for fast rail in CA, U.S., and world expressed in revenue per year (Source- "Rail System Components," Project California Update, Vol. 2, n. 1, Feb., 1993, p. 7).

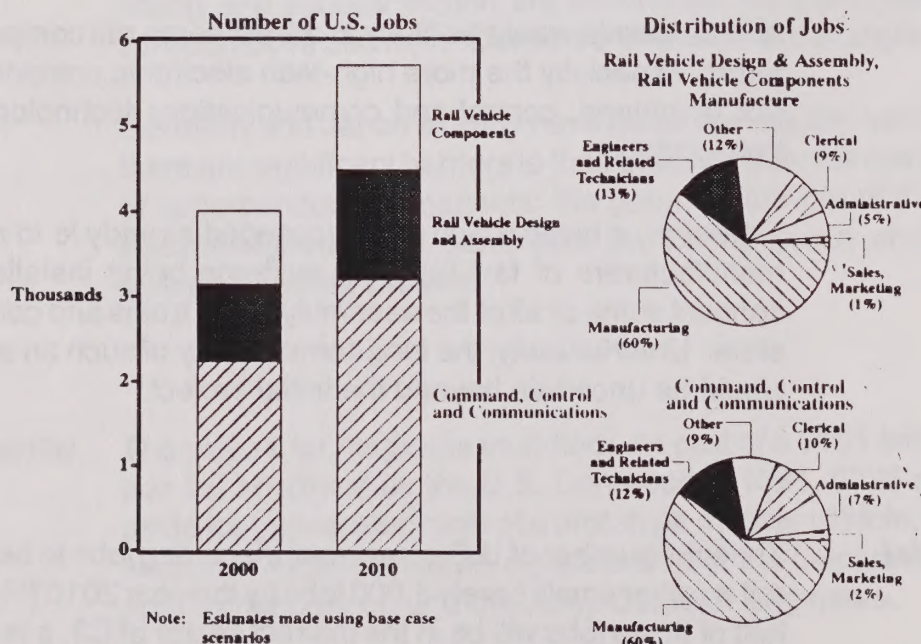


Figure VII-13: Projected # of U.S. Jobs to be created by the different sectors of fast rail manufacturing and the distribution of these jobs into different types (Source- Same Figure VII-12)

These job figures of course do not reflect the many numbers of supporting jobs, such as construction in the building of tracks and service jobs once the train systems are developed. (Projections of the number of these jobs have not been done.)

***Environmental,
Health & Safety
Issues***

Further analysis needs to be done on the potential environmental impacts of high speed rail-related manufacturing, based on the specific components to be fabricated.

***Infrastructure
requirements***

Assembly of rail cars will require large warehouse-type space. Energy needs would be substantial. Minimal training would be necessary for assembly workers. Some engineers and other management/support staff would be needed. A more definitive determination on the market feasibility/political debate surrounding high speed rail is needed before a recommendation on siting a rail car manufacturing facility at a closing northern California military base can be made.

***Companies,
Agencies and
Associated
Organizations***

ABB Traction Inc., 425 Phillips Blvd., Trenton, NJ 08618

(609) 538-0900. U.S. subsidiary of the company that builds the Swedish X2000. Builds locomotives, railcars, traction power substations and propulsion equipment.

Amtrak/ National Railroad Passenger Corporation, 60 Massachusetts Ave., N.E., Washington, DC 20002. In California, contact Bruce Heard, (213) 891-3475

Bechtel Group Inc., 50 Beale St., San Francisco, CA 94105
Contact: Joe Perskowski, (415) 768-0560

Grumman Corp., 1111 Stewart Ave., Bethpage, NY 11714-3580
(516) 575-0574

Federal Railroad Administration, Washington, D.C. Contact: Joe Harding, (202) 366-6144

Technology Reinvestment Project, U.S. Department of Defense Advanced Research Projects Agency. Offers matching grant program; 41 projects with 272 industrial sponsors announced in 1993. Of a total \$475 million in funds, approximately half went to transportation projects.

U.S. Department of Transportation. Spending approximately \$700 million annually on research/development and commercialization of advanced transportation technologies. Contact: Federico Pena, Secretary, 202-366-4000.

Interviews

Amtrak: Bruce Hear

Federal Railroad Administration: Joe Harding

"High speed Rail," Amtrak News

"Mass Transit and Fast Rail" Project California Insight, special series, No.5, July 1993

"U.S. developers join magnetic rail push" *Mechanical Engineering-CIME*, v115,n8 (Aug., 1993): p.74

"Tilting trains smooth out the curves," *Mechanical Engineering-CIME*, v115, n2 (Feb, 1993): p.62

"The need for speed," *Mechanical Engineering-CIME*, v114, n11 (Nov., 1992): p. 55

"Rail System Components," Project California Update, Vol.2, n.1 (Feb., 1993): p.7

APPENDIX 5

Summary of additional alternative transportation fuels

(Please see the Advanced Transportation section for detailed information on solar and fuel cell automotive energy.)

Propane (Liquified Petroleum Gas, or LPG) - LPG is a by-product of oil production and refining, and is also produced during natural-gas processing.

Advantages:

- + Lower carbon monoxide emissions than gasoline
- + Reduced threat to land or water from spillage
- + Very narrow flammability-limit range
- + Currently very low price
- + Inexpensive hardware modifications
- + Well suited to larger, heavier fleet vehicles

Disadvantages:

- Limited supplies
- Made from nonrenewable, fossil-fuel resource
- Cumbersome fuel tank

- More frequent refueling than gasoline
- No significant reduction in carbon dioxide emissions
- Nitrogen oxides emissions could increase
- Expands quickly and easily, with potential to cause tank rupture
- Heavier than air, so poses safety hazard in the event of leakage
- Very low flashpoint; can spark at lower temperatures

Methanol - A form of alcohol, methanol is primarily produced from natural-gas feedstocks, and can also be derived from coal, oil, organic wastes, crops, and wood. Even though methanol can be mixed with gasoline which eases the shift to this alternative, dedicated use of methanol will probably not become cost-competitive with either gasoline, CNG, or LPG without government mandates or incentives. Alcohol fuels may have limited air-quality benefits in certain regions, and methanol will increase greenhouse-gas emissions if new coal sources are used as feedstocks.

Advantages:

- + Lower carbon monoxide emissions than gasoline
- + Higher engine power rating than gasoline
- + Few engine modifications required for dual-fuel capability
- + Good antiknock fuel
- + Possibly lower nitrogen oxides emissions than gasoline. Hydrocarbon emissions thought to be less photochemically reactive than those from gasoline

Disadvantages:

- weather
- More frequent refueling stops or larger fuel tank needed
- Highly corrosive to metal, rubber, and plastic components
- Highly toxic
- Soluble in groundwater; could lead to water contamination
- Formaldehyde by-product is a suspected carcinogen

- Nonrenewable resources may be required; uses imported natural-gas and oil feedstocks
- High greenhouse gas and other emissions when made from coal
- Wide-ranging flammability limits
- Volatile
- Conducts electricity
- Very high capital cost to produce
- Predominantly an imported fuel if widely used

Ethanol - Another form of alcohol, ethanol is produced from fermenting sugars of crops such as corn, and from trees, shrubs, grasses, and waste biomass. Even though ethanol can be mixed with gasoline, dedicated use of ethanol will probably not become cost-competitive with either gasoline, CNG, or LPG without government mandates or incentives. Alcohol fuels may have limited air-quality benefits in certain regions, and ethanol can reduce greenhouse gases if woody biomass is used as feedstock instead of corn and other food crops.

Advantages:

- + Few engine modifications required
- + Good antiknock fuel
- + Made from renewable resources
- + Can reduce greenhouse-gas emissions depending on crop-growing requirements
- + Cellulose conversion could be cost-competitive in future
- + Hydrocarbon emissions thought to be less photochemically reactive than those from gasoline
- + Low toxicity
- + Currently enjoys a federal tax subsidy
- + Domestic resource base

Disadvantages:

- Can require large volume of crops and energy to produce
- Current distillation methods are very energy-intensive
- More frequent refueling or larger fuel tank needed
- Limited supplies for dedicated use when made from crops such as corn
- Crop fertilizers could pose a problem to groundwater
- High flashpoint and wide flammability limits could form flammable mixtures in vehicle fuel tank
- Degrades some elastomers and metals it comes in contact with
- May be impractical to distribute by pipeline network
- Hard to start vehicle in cold temperatures
- Corrosive
- Currently expensive

Reformulated Gasoline - This fuel is made from petroleum, with crude oil as its principal resource base. Reformulated gasoline was designed as a first effort to address air pollution in our dirtiest cities. In the near term, many of these cities would benefit from a switch to reformulated gasoline. In the long run, it has nearly all the problems of gasoline: resources are not adequate or secure; greenhouse-gas emissions will increase; and oil spills will continue.

Advantages:

- + Few engine modifications required
- + Few engine modifications required
- + No hardware modifications required to vehicle or refueling station
- + Distribution system in place
- + Lower reactive-hydrocarbon and sulphur oxides emissions than gasoline
- + Narrow flammability limits
- + Not appreciably more expensive than current gasoline blends

Disadvantages:

- Uses imported oil feedstocks
- Highly toxic
- Leakage contaminates water resources
- Oil spills threaten species on land and in water, and create air pollution
- Low flashpoint, thus explosive
- Very low autoignition temperature, thus small leaks into air can readily cause fires
- High capital cost to retrofit refineries
- Asphyxiant at high temperatures
- Little improvement when used in new cars

Oxygenated Additives to Gasoline - Methyl tertiary butyl ether (MTBE) and ethyl tertiary butyl ether (ETBE) - MTBE is derived from the butane in crude oil, and ETBE is made from oxygenating ethanol or from biomass (crops). Oxygenated additives reduce only selected air emissions and are thus best used in regions where carbon monoxide standards have been exceeded. These additives do not reduce greenhouse gas emissions.

Advantages:

- + No engine modifications required
- + Pipeline distribution system in place for oxygenated blended fuels
- + Lower carbon monoxide emissions than gasoline
- + Conventional engines burn these fuels more efficiently

Disadvantages:

- Nonrenewable resource base (MTBE)
- Vapors are highly toxic
- Asphyxiant at high temperatures

- Leakage contaminates water resources
- Relatively expensive, depends on tax credits to remain competitive

Hydrogen - Hydrogen is made from natural gas, coal, oil or water. Hydrogen holds promise for the future but only if made from nonfossil resources. If coal were used to produce it, both greenhouse and other emissions would rise.

Advantages:

- + Renewable resource when made from water
- + Innovative storage techniques (carbon granules) are lightweight, less bulky, and safe
- + Lower flammability limit in air than gasoline
- + Disperses quickly upon release
- + No carbon monoxide, hydrocarbon, or sulphur oxides emissions from the vehicle
- + Minimal nitrogen oxides emissions
- + Nontoxic
- + Well suited to certain fleet vehicles (e.g., buses)

Disadvantages:

- Nonrenewable resource when made from fossil fuel
- Metal-hydride storage is very heavy and voluminous
- In gaseous form, explosive and costly to refuel
- Asphyxiant at high concentrations
- Hydrogen-distribution and fuel-storage systems remain

Source

Briefing Paper: Alternative Transportation Fuels, Union of Concerned Scientists

- ¹ Paul Helliker, Principal Engineer. CalStart.Planning & Conservation League Symposium, January 8, 1994.
- ² If 15 percent of the vehicles in the U.S. were converted to run on natural gas, foreign oil imports could be reduced by 1 million barrels per day.
- ³ Joe Caves, Joseph Caves and Associates, Planning & Conservation League Symposium, January 8, 1994.
- ⁴ Paul Helliker, Principal Engineer. CalStart.Planning & Conservation League Symposium, January 8, 1994.
- ⁵ Pollution from burning the fuel itself accounts for its "primary emissions," while secondary emissions (those from extracting and producing the fuel and transporting it to market) characterize its full-cycle emissions.
- ⁶ For safety reasons, however, slow fill home compressors are not recommended. Most CNG refills will occur in industrial areas with higher-pressure gas mains.
- ⁷ CARB requires that a LEV must emit no more than 3.4g/mi. of carbon monoxide, 0.2g/mi. of nitrous oxide, and 0.075g/mi. of NMOG; NGVs fall into this category.
- ⁸ A project of Enfuels Corp., a joint venture of Enron Corp., Transco Energy Co., Entex Inc., and AutoGas Systems Inc.
- ⁹ Richard D. Farman, Chairman, Southern California Gas Company, in *Oil and Gas Journal*, "Use of CNG as auto fuel proliferating," Oct. 5, 1992.
- ¹⁰ This battery is used in the G-Van passenger van (developed by an EPRI-led consortium to achieve a 60-mile range on an eight-hour charge) and GMC's prototype 2-passenger car, the *Impact* (to run for 120 miles).
- ¹¹ The latest two require extremely high temperatures to operate: sodium-sulfide=300-700 °C, lithium-iron sulfate=723 °C. The nickel-iron is too high maintenance, needing constant addition of water or electrolyte.
- ¹² "Electric Vehicles," Project California Insight, special series, no.2, June, 1993, page 7.
- ¹³ Paul Helliker, Principal Engineer. CalStart.Planning & Conservation League Symposium, January 8, 1994.
- ¹⁴ Joe Caves, Joseph Caves and Associates, Planning & Conservation League Symposium, January 8, 1994.
- ¹⁵ Ibid.
- ¹⁶ "California firms to get \$50 million," *San Francisco Chronicle*, Dec. 5, 1993.
- ¹⁷ For example, the cost per kilowatt hour for a conventional lead-acid car battery (lifespan of three years) is \$90 versus \$200 for a nickel-metal-hydride battery (eight year life). Source: California Air Resources Board.
- ¹⁸ Terry Price of Solar Electric Engineering indicated such a commitment would serve as a strong incentive for the company to expand from their Los Angeles facility. Assembling only 50 vehicles a year, SEE's staff of 120 is operating at 50 percent capacity.

- ¹⁹ The X2000 has flexible steering that allows the wheels to hug the rail and permits it to drive around turns much faster than most other trains. Furthermore, all of the train, except the locomotive, tilts as it winds its way around the curves. The tilting compensates for the centrifugal force on passengers at high speeds, making high speed train travel extremely comfortable.

CONCLUSIONS

Section VIII

A. Summary

Following a brief summary of the background and the objectives of the study, the following conclusions are drawn from the study:

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Conclusion

Attracting environmentally focused industries and environmentally benign small businesses to closed military bases will be a great challenge, potentially requiring significant changes in the traditional approach to economic redevelopment:

Fundamental to making transitions to green industries in a region will be the establishment of new regulations, pricing policies and other policy reforms that expand the value placed on the environmentally sound approaches. Instead of the traditional economic development view in which environmental waivers are thought of as key to retaining industries, more *advanced* local regulatory policies especially in combination with technical and capital assistance, play a key role in advancing these industries.¹

Conversion of California military bases constitutes a tantalizing opportunity to create neighborhoods that are pedestrian-friendly, transit-accessible, include a mix of commercial space and high-density/low-cost housing and offer ample recreational and open spaces. Strictly defined, a truly sustainable neighborhood would also assume responsibility for production, composting, recycling and reusing of the majority of products it consumes, reducing waste and consuming only what it needs, to assure adequate resources for multiple generations to come.

Obviously, the modern urban environment is light-years removed from this ideal. Nevertheless, environmental sustainability—coupled with progressive, enlightened population growth policies—must be a long-term goal which guides land-use and economic planning if humankind is to thrive. As Arthur James of the Urban Habit Program/Earth Island Institute has said:

A closed military base should be converted into a model neighborhood. The framework should be a sound, sustainable way of life, based on the ideas of social justice, and ecological sustainability—a place where experimental, innovative technology is used, and where the business and economic principles are collective ownership and cooperatives. The neighborhood would take in cultural diversity, and a central planning issue would be to create opportunities for poor people of color.

Sierra Club San Francisco Group is hopeful about the chances for realizing this vision at decommissioned California military bases. This report, **Discovering Environmentally Sustainable, Career Jobs at Closing Military Bases**, focuses on businesses that have potential to provide a range of meaningful blue collar, white collar, entry level and entrepreneurial employment for people living near closing military bases.

In some instances, the report also identifies local job training, education and placement programs, and links these programs to expanding environmental job opportunities that are projected to occur over the remainder of the century and beyond.

As more and greater environmental and social concerns about "business as usual" are brought to bear, U.S. employment patterns are changing drastically. This report indicates vacated northern California military bases can be on the leading edge of this transition.

Additional Industries to Research

Because this document is not all-inclusive, many other environmentally sustainable job creation opportunities for northern California military bases were not covered. This paper was written on a volunteer basis, requiring research to be limited to a few key business sectors due to human resource limitations.

The following products, companies and services may have potential to create career jobs in environmentally sustainable industries. Additional research needs to be conducted to determine feasibility, infrastructure requirements, environmental sustainability, etc. of these ideas.

Energy

Design/manufacturing of energy-efficient lighting and appliances: compact fluorescent and halogen light bulbs; light bulb adapter kits (to allow use of compact fluorescent bulbs in conventional sockets and fixtures); dishwashers; clothes washers; furnaces and boilers; central heat pumps; and water heaters.

Commercial weatherization. The U.S. EPA and the state of California have implemented a five-year efficiency improvement program to reduce the energy used for lighting state office buildings. Under the program—called "Green Lights"—about 70 million square feet of space will be equipped with high-efficiency lighting, reducing the state's energy use by more than three billion kilowatt hours within five years.²

High Technology

Multimedia. Thousands of jobs in animation, video production, sound production, set design, acting and other disciplines are likely to be created by the fledgling Bay Area multimedia industry. San Francisco is the world center for new computer applications that will take advantage of computer networking, moving image and interactive technologies. The multimedia business is clean, uses little space and creates high-paying jobs.

Transportation

Manufacturing of light rail cars. If CalTrain is extended to downtown San Francisco, it will be converted to light rail, creating retrofitting and manufacturing jobs. If qualified and approved by voters, a new transit initiative, the California Clean Air, Jobs and Transportation Efficiency Act (CALTEA), would raise at least \$700 to \$725 million annually for investment in light, commuter and intercity rail, among other transit projects.

Manufacturing of three-wheel bicycles with tote capacity and small engines for hill climbing.

Bicycle path construction.

Manufacturing/assembly of natural gas compressors for automobile refilling stations.

The Arts

Arts Center. The Mayor's Hunters Point Shipyard Citizens Advisory Committee is exploring establishing an arts center, to build on the existing large community of artists living and working at the shipyard. Many of the recommended arts uses developed during the community planning effort have good potential to create environmentally benign jobs. Such a center would also build on an existing core of businesses, improving chances for success.

Service Sector

Telemarketing/800 number order taking firms. These firms conduct fundraising campaigns, market financial and other products, take credit card orders, track sales and manage sales data, fulfill literature requests from direct mail campaigns, register callers for seminars, qualify sales leads and refer sales inquiries to regional dealers. Some of the largest Bay Area telemarketing firms include:

- Proxy Message Center of San Francisco, 140 Valley Drive, Brisbane, California 94005. 1-800-776-9980
- Zacson Telemarketing, 3825 Hopyard Road #275, Pleasanton, CA 94588. 415-463-1975
- Telespectrum, Suite 240, 501 Second Street, San Francisco, CA 94107. 415-777-2169
- Marketing Connections, One Annabel Lane, Suite 212, San Ramon, CA 94583. 510-866-1818
- TBS Marketing Corporation, 3541 Investment Boulevard, Suite 3, Hayward, CA 94545. 510-732-5000

Catering companies, microbreweries and bakeries.

Office space/meeting facilities. A long-term prospect for redevelopment is to attract federal agencies to site branches at decommissioned military bases. For example, the U.S. Forest Service has considered relocating its San Francisco regional headquarters—which employs 400—to Sacramento to cut costs. Several closed military bases (Presidio, Moffett Field, Mather Air Force Base, Mare Island Naval Shipyard) are under consideration.

The current infrastructure at many bases does not offer adequate office space. And few, if any, career jobs would be created for residents of nearby neighborhoods by such redevelopment. However, a new day-time population of professionals with discretionary income at the bases could support many new service-based jobs (copy shops, restaurants, etc.).

Miscellaneous Environmental Businesses

Other environmental technologies/businesses, including analytical laboratories, environmental equipment manufacturers, remediation research and development firms, etc.

“Green” smoke detectors that do not contain radioactive materials. Contact: Healthful Hardware, 602-445-8225.

Nontoxic building products (carpeting, paints, etc.). Contact: Environmental Construction Outfitters 800-238-5008; or Hendricksen Naturlich Flooring & Interiors, 6761 Sebastopol Avenue, Sebastopol, CA 95472 707-829-3959.

Converting vacant lots to raised bed food gardens.

Additional Informational Resources

Alameda Center for Environmental Technologies (ACET), Proposal for Defense Conversion and Reinvestment in Alameda, Alameda County Economic Development Advisory Board, January 21, 1994. Describes broad variety of potential environmental industries.

Military Conversion

Assembly Task Force on Defense Conversion Bulletin, newsletter produced by the California Assembly Task Force on Defense Conversion. 1-800-337-5600.

California Military Base Reuse Task Force, a 15-member committee to promote the rapid conversion of decommissioned military bases and other defense facilities to civilian use. Governor’s Office, Sacramento,

CA 95814. Contact: Dara Lynn Cox, 916-322-3170

Citizen's Guide to Base Conversion, Pacific Studies Center, contact Lenny Siegel ph. 415-969-1545.

Defense Conversion Resource Guide, geared to helping California small businesses capitalize on military conversion. Includes directories of federal and state agencies, descriptions of available grants, summaries of relevant legislation and other reference materials. Produced by the Assembly Task Force on Defense Conversion, State Capitol, P.O. Box 942849, Sacramento, CA 94249-0001, Barbara Lee, Chair. 1-800-337-5600.

Governor's Report on California Military Base Closures, a summary of the effects of base closures. Governor's Office of Planning and Research, 1400 Tenth Street, Sacramento, CA 95814. Contact: Richard Sybert, Director.

U.S. Office of Economic Adjustment grants. A Department of Defense program that provides funds to communities affected by base closures.

***Small Business
Assistance***

A list of largest Bay Area Small Business Administration lenders (compiled by the San Francisco Business Times) is attached.

Self-Employment and Enterprise Development (SEED), a program to help low- and moderate-income San Francisco residents start up and run small businesses. Mayor's Office of Community Development, 415-775-8880 or 415-554-8765.

Largest Bay Area SBA Lenders

Published May 7, 1993

Ranked by total value of loan amount granted locally ¹ , FY '92			Gross loan amount granted locally in 1992	No. of local SBA loans	% Of local SBA loans for real estate	% Of local SBA loans for working capital and equipment financing	Minimum SBA loan amount	Maximum SBA loan amount	No. of local office locations	Top Bay Area SBA executive
Rank	Rank last year	Company name Address Phone/Fax	SBA guaranteed amount							
1	2	Heller First Capital Corp. 650 California St., 23d Floor, San Francisco 94108 ² 274-5700/ 274-5711	\$22.75 million \$18.13 million	53	65%	35%	None	\$1 million	NA	Donna Jordan
2	1	Truckee River Bank P.O. Box 80, Truckee 96160 (916)582-3000/ (916)582-3047	20.33 million 16.26 million	57	NA	NA	25,000	1 million	1	Dave McLean Steve Mattam
3	14	Bay Area Development Co. 251 Lafayette Circle, Suite 220, Lafayette 94549 (510)283-3760/ (510)283-4210	18.48 million ³ 5.07 million	10	85%	15%	100,000	1 million	1	James Bayrd
4	12	Bay Area Business Development Co. 150 Fourth St., Suite 220, San Francisco 94103 541-0694/ NA	17.9 million 7.6 million	15	100%	0	450,184	642,700	1	Frank Federico
5	3	Money Store Investment Corp. 2107 North First St., Suite 570, San Francisco 94105 (800)722-3066/ (408)441-0304	15.56 million 12.44 million	38	75%	25%	50,000	1 million	4	Larry Wodanick
6	4	Bank of Oakland 360 14th Ave., Oakland 94612 (510)763-8492/ (510)763-4426	14.01 million 11.47 million	42	40%	60%	35,000	1.1 million	2	Robert Roman
7	No on list	East County Bank N.A. 315 G St., Antioch 94509 (510)778-8090/ (510)754-8924	11.34 million 9.64 million	41	3.5%	96.5%	50,000	1 million	1	Kathy Bleikley
8	6	Sacramento Commercial Bank 525 J St., Sacramento 95814 (916)325-4847/ (916)443-7345	7.88 million 6.53 million	33	18%	82%	50,000	1 million	0	Gerald Smith
9	18	Government Funding 598 Market St., Suite 2500, San Francisco 94111 882-9515/ 979-0360	7.8 million 6.27 million	31	30%	70%	50,000	950,000	1	Miles Jensen
10	Not on list	Bank of Commerce N.A. 1100 Shoreline Hwy, Suite 2958, San Francisco 331-4849/ 331-5910	7.67 million 6.14 million	22	97%	3%	100,000	1 million	1	Jeff Birkholz
11	11	Commercial Bank of San Francisco 333 Pine St., San Francisco 94104 627-0303/ 296-7287	6.28 million 4.83 million	18	87%	NA	50,000	1.3 million	1	Janine Perrignon
12	10	Liberty National Bank 3 Altarinda Road, Suite 308, Orinda 94563 (510)253-9776/ (510)253-0132	5.51 million 4.6 million	16	56%	44%	50,000	1 million	1	Steve Giacomini
13	13	Bank of America Community Development Bank 315 Montgomery St., Suite 1600, San Francisco 94104 622-1505/ 622-1671	4.34 million 3.75 million	30	0	100%	25,000	1.25 million	2	Ed Loescher
14	15	Concord Commercial Bank 2118 Willow Pass Road, Concord 94520 (510)798-2233/ (510)798-0178	4.14 million 3.52 million	20	15%	85%	75,000	1 million	1	Peter Burnett
15	9	Burlingame Bank & Trust Co. 350 Primrose Road, Burlingame 94010 348-2500/ 342-3356	3.8 million 3.08 million	14	14%	71%	None	1 million	1	Thomas Welch
16	20	California Business Bank N.A. 95 S. Market St. San Jose 95110 (408)298-8866/ (408)288-8900	2.54 million 2.17 million	10	50%	50%	100,000	1 million	1	Lester Crabbs
17	Not on list	National Bank of the Redwoods 111 Santa Rosa Ave., Santa Rosa 95403 (707)573-4857/ (707)644-3116	1.36 million 750,000	1	100%	0	50,000	1.4 million	0	Patrick Kilkenny
18	23	Westamerica Bank 9 Commercial Blvd. (9-R), Novato 94949 382-6013/ 392-6297	1.02 million 1 million	4	50%	50%	25,000	882,353	18	Russell Mills
19	Not on list	Silicon Valley Bank 3000 Lakeside Dr., Santa Clara 95054 (408)982-3724/ (408)727-8728	900,000 582,000	3	0	100%	100,000	None	1	Granville Miller
20	Not on list	Sonoma National Bank 755 Fourth St., Santa Rosa 95404 (800)286-4949/ NA	730,000 620,500	2	100%	0	None	2.5 million	3	Craig Cazet

This list includes banks according to the total amount loaned to small businesses in the five counties of Alameda, Contra Costa, Marin, San Francisco and San Mateo.
Tracy Federal Bank, ranked 5th last year, distributed \$48.7 million in SBA loans statewide, but could not break down the percentage granted to Bay Area businesses, and therefore could not be ranked.

A representative of Barbary Coast National Bank, San Francisco, ranked eighth last year, said the bank is not an active SBA lender in the Bay Area.

Sources include Small Business Administration and representatives of each company.

Footnotes:

NA= information not available

¹Refers to the five counties listed above.

²Effective May 24, 1993.

³Bay Area Development Company is a CDC-504 program lender, in which SBA guarantees a maximum of 40 percent of each project financed. As a result, SBA granted share for fiscal 1992 was \$5.08 million, but total financing arranged was \$18,484,000.

Researcher Biographies

Merry Ann Moore, Research Director, served as chair of Sierra Club/ San Francisco Group in 1993 and served as a board member for the Group's Executive Committee from 1991 to 1993. She is a professional writer and principal of Moore Creative, a public relations company specializing in environmental issues founded in 1990. Ms. Moore's articles on recycling, solid waste, lead poisoning, toxic waste cleanups, environmental legislation, forestry and other topics have appeared in multiple environmental publications across the country. She received a 1993 Sierra Club Bay Chapter Conservation Award for *Kids at Risk*, a video production on preventing childhood lead poisoning. She is also a member of the California Economic Recovery & Environmental Restoration Project (CAREERPRO).

Ms. Moore is a 1984 *cum laude* graduate of Harvard University and a 1985 Rotary Scholar (Montpellier, France). She has been a Sierra Club member since 1986.

Linda Bagneschi, Research Associate, is a management consultant specializing in environmental and agribusiness sectors at Deloitte & Touche, a "Big Six" accounting and consulting firm. She is a 1991 graduate of the University of California/ Berkeley with a B.S. degree in business administration. She is an environmental activist for Sierra Club and the International Society for Ecology and Culture. Ms. Bagneschi plans to transition to the environmental non-profit sector on a full-time basis. She has been a Sierra Club member since 1992.

Marty Farris, Research Associate, is an MBA graduate student at San Francisco State University. He graduated from the University of California/Berkeley with a degree in social sciences. He is a coordinator for SFSU's Community Involvement Center, which matches student volunteers with community projects. He is also a finance advisor and volunteer coordinator for Yahoo Urban Ecology, a start-up venture selling retail urban gardening supplies and advising school kids and multi-lingual customers on how to create productive urban gardens.

Tom Kirk, Research Associate, is a consultant specializing in the interrelationships between land use, transportation systems and air quality. He graduated *magna cum laude* from the University of California, Los Angeles with a degree in geography. Mr. Kirk is also a Coro Foundation public affairs graduate. He is currently pursuing a Master's in City and Regional Planning at the University of California/Berkeley, and is a fellow of the University of California Transportation Center.

Clayton Mansfield, Research Associate, is an attorney in private practice. He is the current chair of Sierra Club/San Francisco Group, and has served as chair of the Sierra Club Bay Chapter Conservation and Nominations/Elections Committees, and the San Francisco Group Conservation Committee. Mr. Mansfield has a Bachelor's degree from Stonehill College in Massachusetts, and a J.D. from Catholic University. He has been a Sierra Club member since 1988.

John Pandolfo, Research Associate, is a teacher, and a consultant on fuel cell technologies. He is a graduate of the University of Connecticut with a degree in chemical engineering. He worked for seven years at United Technologies, and also at International Fuel Cells Corp. and ANSI Corp., performing research and development on fuel cells. Mr. Pandolfo recently spent one year in Italy consulting on fuel cells. ~~He has been a Sierra Club member since ??~~

Chi Tran, Research Associate, is a professional researcher at the University of California/San Francisco Department of Biochemistry and Biophysics. She is a 1988 graduate of the University of California/Berkeley with a degree in microbiology and a minor in German. She plans to attend law school in Boston in 1995, to specialize in international law. She has been a Sierra Club member since 1991.

Billie Blanchard, Research Assistant, is a professional environmental planner with the California Department of Toxic Substances Control, Cal-EPA. She has 18 years' experience in state and local planning, and has worked for three southern California counties and the California Coastal Commission. She has an M.S. degree from the University of Arizona in planning, and an M.A. degree in political science from the University of Maine. Ms. Blanchard has been a Sierra Club member since 1975.

¹ Sanford Lewis, "Eight Principles of Genuine Partnership and Empowerment for Sustainable Industrial Development," Good Neighbor Project for Sustainable Industries, Acton, MA, p. 9.

² The California Energy Commission, 1992-1993 California Energy Plan.

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